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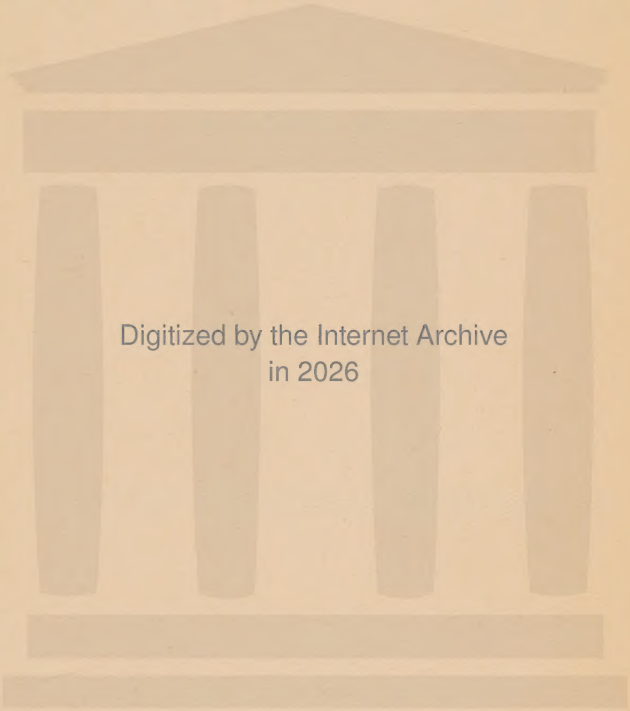
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REPORTS

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REPORTS

ON THE

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PART II.

Presented to both Houses of Parliament by Command of Her Majesty.

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REPORTS.

On Class I. Mining and Metallurgical Products.—By Warington Smyth, M.A., F.G.S.

To the Right Hon. Lord Stanley of Alderley, President of the Board of Trade.

My Lord,

I have the honor herewith to transmit a report on Class I. of the "Exposition Universelle," of 1855.

Classification in the French Exhibition.

At the very outset of a critical study of the relation of the Industrial Exhibition of London in 1851 to that of Paris in 1855, a remarkable difference was to be observed in respect to the arrangement. In 1851 the practical tendency of the English mind united under one head the natural objects and the various implements or modes of operation which belong to one business; in 1855, the more analytical tendency of the French so separated the different items appertaining to one craft, that, whilst its raw materials were to be found in a certain class, the apparatus by which they are worked had often to be sought out in distant localities, and their merits discussed by judges conversant rather with the general principles than with the particular application of the subjects. Certain discrepancies of this kind can scarcely be avoided in an exhibition of so general a description, and in the French Exposition they were occasionally obviated by "*réclamations*" made from one jury to another.

The objects contained in the First Class—that of Mining and Metallurgy, were classified under nine heads, as follows:—

1st Section. Maps, models, tables, and collections of a general character.
2nd. Processes of the working of mines.
3rd. General processes of metallurgy.
4th. Extraction and preparation of mineral fuel.
5th. Cast and wrought iron.
6th. Ordinary metals (excepting iron).
7th. Precious metals.
8th. Mints and coinage.
9th. Non-metallic mineral substances.

Mr. Smyth on Mining and Metallurgical Products.

General character of objects in Class I.;

not easily appreciated by the public.

With few exceptions, the products of human industry belonging to the First Class are not of a character to attract the attention of a casual observer. Even the appreciation of the native substances here exhibited requires an amount of previous study which cannot be looked for except in a very small per-centage of the more educated visitors. And if this is the case as regards their natural properties, still more is it observable with reference to the modes of extracting them from their parent sites, and preparing them for application in the arts. The spectator who rapidly brushes past a row of tawny, lustre-lacking ironstones, or throws a momentary glance over a series of glistening ores of copper, obtains from these specimens no idea of the practical sciences which hunted up the dwelling-places of such minerals, of the skilful, perilous handicraft which attacked them underground, or of the divers engines and apparatus which were needful for the operation of working them. An occasional model or plan, illustrating some special process in a particular place is all that can be expected; and the main interest of objects the most important to civilized man remains a sealed book to all but those who have devoted some attention to the structure of our earth, and to the methods which are employed for adapting its constituents to the useful purposes of life.

The finished products of the labour of the miner and metallurgist may be expected to command more general attention. The cake of silver, the railway bar, or the brilliant tin-plate are presented in the character under which they are known to a large portion of the public; and yet the chief interest, nay, the sole importance of these substances, depends on a variety of particulars which a mere collection cannot illustrate. Of their comparative excellence some judgment may be formed from their external appearance, but as regards the merit of their production, as well as their value to the country which produced them, a great amount of collateral information is again needed. It is indispensable for a just appreciation, that we should be acquainted with the nature and abundance of the raw material employed, with the processes used, and, lastly, with the price at which they can be introduced into the commerce of the world.

Comparison of British exhibits with those of 1851.

A single glance at the First Class of the British part of the Exposition sufficed to show a marked difference from that of 1851. The gigantic masses of fossil fuel, the spring of our commercial greatness, were absent; those huge blocks of coal, in some cases illustrating only the peculiar cleavage and character of certain seams, in others re-con-

structing at the surface the pile of successive layers worked in the depths of the earth, were so costly to the exhibitors in Hyde Park, as to preclude, unless some special reason existed, their being thus extracted for a second occasion.

Still more was it observable that there was scarcely a trace of the bold rocks of metallic ore which in 1851 represented with a sort of rude grandeur, although not always, with scientific meaning, the varied and abundant mineral treasures which enrich our islands. Nothing like the monster crystals of Galena from Snailbeach and Laxey, nothing equal to the section of the Duke of Devonshire's lode at Grassington,* nothing recalling the fine blocks of Cornish tin-ore, caught the eye on first entrance; and closer examination made it evident that, as regarded our raw materials, *Britain was most inadequately represented.*

It can scarcely be expected that I should here discuss the reasons for this deficiency, nor whether so important a purpose be answered by their exhibition as to counterbalance the objections of inconvenience and cost in the extraction and carriage of such specimens. But assuming, in the general spirit of a Universal Exposition, that a fair representation of the natural products of each country is desirable, and instituting a comparison with other nations, it was matter for regret, that Great Britain, *so far as she was here represented*, played a part subordinate to several of the European countries.

In 1851 the appeal to the country roused a certain amount of enthusiasm among the owners or workers of mines, but in 1855 a general lukewarmness must have prevailed, based partly on a want of organization, and partly on the improbability of the trouble and expense being rewarded by any remuneration. What our neighbours will do for glory, we hesitate to commence unless assured that it will "pay."

The great majority of the objects belonging to Class I. were arranged at the eastern extremity of the "*Annexe*," where amid abundant light and space, the well grouped castings of Coalbrookdale led, worthily, to the excellent collection of British irons arranged by Mr. Bird, and the useful though less attractive one of the coals of Britain, sent by the Board of Trade. Some few things belonging to the same class were placed in the gallery of the Great Palais, whilst certain others were with difficulty to be sought out among the machinery at the other end of the Annexe.

* This fine illustrative specimen, judiciously selected and prepared by Capt. Eddy, was presented to the Museum of Practical Geology, Jermyn Street, in the hall of which institution it now stands.

Mr. Smyth on Mining and Metallurgical Products.

The examination of these objects for their own intrinsic interest would subserve a certain use in giving information and suggesting inquiry to all visitors of intelligence; but the higher purposes of such an exhibition can only be attained by conducting the examination in such a manner that,—

Subjects of inquiry.

1st. We may compare the degree of art and science employed with that of the last Universal Exhibition.

2ndly. We may form conclusions by comparison with the productions of other countries as to our own relative present position, and as to the respective rates of progress during the last few years.

I propose, therefore, to take seriatim the articles exhibited in the British Section, to compare them when needful with the analogous objects of the Exhibition of 1851, but more especially with the Foreign Collections of that of 1855.

First Section.

Maps, Models, Tables, and Collections of a general Character.

Geological maps:

In the department of maps our country occupied a most honourable position.

Britain,

A gold medal was awarded to the Geological Survey of Great Britain, the great work commenced by the late Sir Henry De la Beche, and now placed under the direction of Sir Roderick Murchison. The gigantic map, formed by placing together all the sheets that have yet been published, has for its groundwork the Ordnance map of one inch to the mile, and was illustrated by sheets of sections on a scale of six inches to the mile.

The execution of this work was admired by all, and its accuracy was so self-evident to those versed in the subject, that most flattering opinions have been passed upon it by men of all nations. There is now not a civilized country in the world which has not organized, at the State expense, some such inquiry into its mineral structure. Some were commenced earlier, some more recently, than our own, but I have no hesitation in affirming, what is borne out by the testimony of many Continental authorities, that the Geological Survey of Great Britain excels, in regard to practically useful detail, all the others which have been produced.*

* Herr Tunner, the Austrian Juror, states, "a very successful portrait produces on the connoisseur such an impression that he can hardly doubt the close resemblance. In this respect the English map far exceeds all others. Especially are the important mining districts in the south and west of England worked out with a detail and accuracy which are not found in any other geological map of an entire country."—*Report on the Paris Exhibition*, p. 13.

Since 1851 considerable progress has been made in the additional sheets which have been published. Much light is thrown on the constitution of our central coal areas, and the rocks by which they are surrounded; and these observations will be most important on the engrossing question which must ere long arise, under what circumstances may we expect to meet with coal in localities where it is concealed by a cover of other formations?

Amateurs have, in England, worked wonders in this direction, but when we consider the necessity for co-ordinating their varying views, and the magnitude of certain questions to be resolved by such a survey, it is evident that it could be conducted only as a national undertaking. Private enterprize has been mainly instrumental, dealing with a more limited area, in producing a very remarkable map of Belgium (Belgian Cat. No. 1). M. Dumont has devoted his life, with unwearied assiduity, to the unravelling of the complicated geological structure of his country; and, although his work is on so much smaller a scale as not to be comparable for practical utility with the English map, a high sense of the merits of the individual was marked by the award of the great gold medal.

Belgium.

The Geological Survey of France, in which Élie de Beaumont and Dufrénoy have been aided by several able collaborateurs, has been well known for many years. An admirable map of Rhine Prussia and Westphalia, prepared under the superintendence of Von Dechen, was a new addition to geological science, and one of a high order. To both of these the same honour of a gold medal was awarded.

France.

Westphalia.

From Austria were sent detailed maps of great merit, exhibiting the geological structure of particular districts of that extensive empire, and an excellent general sketch map of the entire monarchy has been published under the superintendance of the Hofrath Haidinger.

Austria.

Though last, not least, the geological map of Canada attracted much attention. Prepared under unusual circumstances of difficulty by Mr. Logan, it was illustrated by an unequalled series of the rocks, the building and ornamental stones, and the various ores produced in that colony; and so complete and scientific was the display, so meritorious the perseverance and skill which had directed the examination of those vast regions, that Mr. Logan was rewarded with the gold medal and the Cross of the Legion of Honour, and subsequently with a knighthood in our own country.

Canada.

Among the other works exhibiting the *geological features of particular districts*, none was so remarkable as the

Mylne's London.

Mr. Smyth on Mining and Metallurgical Products.

admirable map of London and its environs, by Mr. Mylne (No. 10). Marking by contour lines the elevations above a given datum, and showing every variation of subsoil upon which our metropolis and its suburbs are situated, this beautiful work, founded upon very extensive observation, is so suggestive, in a sanitary point of view, that a copy of it ought to be in the hands of every engineer, architect, and amateur engaged in building or in modifying the surface and under-ground arrangements of this great centre of population.

Mineral collections.

As regarded *general collections,* which formed a part of the First Section, nothing was exhibited by Great Britain, with the exception of—1st, a small series collected by myself for the Council of the Duchy of Cornwall, in order to illustrate the occurrence of metallic minerals in lodes, especially the variation of character, according to the depth and containing rock; and, 2dly, of a series contributed by the Museum of Irish Industry. The most remarkable efforts from foreign countries in this direction were,—

1st. A very complete collection illustrative of the useful mineral substances of Bohemia, sent by a private association, the Society for the Encouragement of Industry in Bohemia.

2d. A series of similar character contributed by the Technical Institute of Tuscany at Florence.

3d. A collection of 1,221 examples of building materials, ores, &c., illustrative of the resources of Piedmont, prepared by the Technical Institute of Turin.

These afforded in each case a valuable epitome of the country, excellently adapted for study or reference, and were treated in a thoroughly practical manner.

As a fourth, may be added the illustration of the minerals of New South Wales, to which, consisting chiefly of very numerous and valuable specimens of gold, both from the stream-works and from the rock, an extensive series of geological specimens, capable of throwing much light on the structure of a new country, had been appended by the Rev. Mr. Clarke, for many years a zealous explorer of that colony.

In the extensive and valuable series of products of Hindostan, contributed by the East India Company, were included many specimens of marbles, coals, and irons, but not in sufficient number, or arranged in such order, as to afford the opportunity of studying special districts. They served, however, the purpose of an additional proof that the material elements for many an improvement are to be found in that great peninsula, and it is satisfactory to know that the Company is now keeping on foot, under Professor Oldham

and an able staff, a close examination of some of the localities which promise to become of the highest importance.

It is only needful here to add that very useful and carefully ordered collections of minerals, rocks, and fossils, intended for educational purposes, were exhibited by M. Saemann,* and by M. Eloffe of Paris, and by Mr. Krantz of Bonn.

Second, Third, and Fourth Sections.

The articles exhibited under the Second Section had reference chiefly to coal mining, whilst those of the Third Section were little else than examples of fireclays and bricks, of the quality of which little could be determined from mere inspection; it will, therefore, be more convenient to class together all that relates to the subject of collieries and their working.

Coals of Great Britain.

Coals and Coal-mining.—Among the coal-producing countries of the world Britain takes the undoubted lead, and to the abundance of her fossil fuel, aided by the widespread system of internal communication which distributes it over the land, she owes her high commercial position. No other country as yet unites these advantages in so remarkable a degree; but several of the European nations have made, during the last few years, such exertions to develope their own resources as to produce an effect of great importance, not only in regard to the supply of combustible for general purposes, but more especially of moment to the manufacture of iron.

The coals of Great Britain were represented, in 1855, not by the isolated huge blocks which were regarded with amazement in 1851, but mainly by a systematic collection (No. 21 of the British Catalogue) of nearly 300 specimens, obtained by the Board of Trade from all the principal districts. The printed labels supplied much information, although the name of the seam was, in many instances, unfortunately omitted.

The local committee of Sunderland contributed a series of small specimens which admirably illustrated the various qualities of coals raised from the districts of the Tyne and Wear.

Mr. William Murray, of Glasgow, similarly illustrated the productions of the coalfield of Lanarkshire by specimens of

* One of the standard collections of Mr. Saemann, as approved by the French Government, has been purchased as an example, and is deposited in the Museum of Practical Geology, Jermyn Street.

Mr. Smyth on Mining and Metallurgical Products.

the coal, ironstone, and limestone, of such value to the Scotch iron-producing region; but their being unhappily chiselled into cubes destroyed the appearances from which their character could be determined by inspection.

Examples of patent fuel were supplied by the Anthracite Steam Fuel Company of Llanelly, No. 18, and by Myers and Co., of Saundersfoot, near Tenby, but they were unaccompanied by the statistics which would have added value to this method of preparing a convenient form of fuel for sea-going steamers.

Coke.

The coke of Northumberland took the highest place in the Exposition, and it was difficult to adjudicate between the rival merits of the fine specimens from Gateshead, and from Marleyhill, both made in ovens, from the low lying seam known as the *Busty Bank*, and now manufactured on an enormous scale in the district situate to the west of Gateshead. As far as the actual production of an excellent coke is concerned, in ranges of large circular ovens, communicating many together, with a single flue, the object is well attained, the more so as the coal from which it is made was almost worthless before the present enormous demand for a good coke for railway purposes arose. Yet it cannot but be matter of regret, looking at the subject in a broad point of view, that so vast a quantity of heat, of ammonia, and other useful products, should be uselessly dissipated. It is not often, perhaps, that such works are placed under circumstances allowing of economy in this respect, but it may be noted as worthy of attention in certain cases, that some of the Belgian works, as near Charleroi, have successfully applied the otherwise waste heat of the coking ovens to generating all the steam required to work the blowing engines of their iron furnaces.

The extraction of coal in Britain has, from various causes, been greatly stimulated within the last few years, and it may be useful to compare the quantity annually raised here with that of some few European nations, not forgetting, however, that the continental countries still in a very great degree depend on wood as their ordinary fuel.

Statistics of British coal.

From the absence of organization and official statistics very little reliance can be placed on early estimates; from 1845 to 1852 the total amount of coal raised in Great Britain used to be quoted at about 34,000,000 of tons. In 1853 Mr. T. Y. Hall, after much investigation, stated that the production had reached 56,550,000 tons.

COAL PRODUCE OF THE UNITED KINGDOM, 1854. (From Mr. Hunt's Mineral Statistics, in the Memoirs of the Geological Survey.)

	Tons.
England.	
Northumberland and Durham	15,420,615
Cumberland	887,000
Yorkshire	7,260,500
Derbyshire	2,406,696
Nottinghamshire	813,474
Warwickshire	255,000
Leicestershire	439,000
Staffordshire and Worcestershire	7,500,000
Lancashire	9,080,500
Cheshire	786,500
Shropshire	1,080,000
Gloucestershire, Somersetshire, and Devonshire	1,492,366
Total	47,421,651
Wales.	
Anglesea, Flintshire, and Denbighshire	1,143,000
Monmouthshire, Glamorganshire, Pembrokeshire	8,500,000
Scotland.	
Total of all the Scotch districts	7,448,000
Ireland.	
Total of all the Irish districts	148,750
Grand Total	64,661,401

This represents, at the average price on the spot, a value of 14,975,000*l.* and involves the direct employment of about 220,000 persons, in no fewer than 2,397 collieries.

France.

Mr. Smyth on Mining and Metallurgical Products.

The area of the 62 coal-fields is given by French authors at about 1,100 English square miles. Descriptions may be found in the "Annales des Mines," the works of Burat, &c.

Coals of France.

Year.	Coal raised in France. Metric quintals.	No. of Mines.	People employed.	Quantity consumed in France. Metric quintals.
1847	51,532,046	258	26,723	78,488,700
1848*	40,004,330	256	24,632	60,952,100
1849	40,492,183	270	25,942	64,054,800
1850	44,335,670	273	32,923	72,252,700
1851	44,850,339	270	33,634	73,768,300
1852	49,039,259	286	35,381	79,585,200

Ten *metric quintals* are so nearly a ton of 20 cwts. that the amount extracted in 1852 may be taken in round numbers as 4,900,000 tons, and at present would probably amount to between 6,000,000 and 7,000,000 tons.

To make up the great deficiency in the quantity of coals consumed in France, she is obliged at present to purchase largely from her neighbours, and there were imported in 1852,—

	Metric quintals.
From Belgium - - -	21,191,800
Great Britain - - -	6,523,900
Prussia - - -	3,242,600
Various - - -	1,300
Total -	30,959,600

Added to the above, France produces annually about one and a half millions of metric quintals of lignite, and four and a half millions of peat.

Progress of French production.

The progress made in the French production of coal within the last half century has been very considerable; viz., from less than 1,000,000 to 6,000,000 of tons; and

* The sudden check given to the production of coals in France was consequent on the Revolution, and the statistics in the above table, as well as those for iron and other metals, show how long a period is required to make up for the steps lost during a time of political disturbance.

great attention has been bestowed on the close investigation of all localities where coal was either known or suspected to exist. The fields of central and southern France differ materially from that of the northern district which borders on Belgium; and as regards many of the former, where the seams are of great but varying thickness, and steeply inclined, it is difficult to propose an estimate as to their total value.

St. Etienne.

Some of the best examples were sent to the Exposition from St. Étienne. Nos. 26 and 27 were large blocks (one of them 7 ft. long by 4 broad and 4 high), from the collieries called *La Chazotte*, *Roche la Molière* and *Firminey*, and were accompanied by coke and bricks of agglomerated fuel, some of cylindrical form, others polygonal prisms, and employed in the French navy. This coalfield, the centre of a most flourishing and varied industry, contains a number of seams which attain severally in places the great thickness of from 10 to 40 feet, whilst the total thickness of the measures amounts, in the centre of the basin, to nearly 5,000 feet.

Results of miner's school.

The establishment of a mining school, now under the able direction of M. Grüner, has tended much to improve the capabilities of the district, by supplying the works with a class of cultivated managers, who are rapidly modifying the old and rude arrangements. The best proof of the value of the school consists in the fact, that although 30 or 40 young men are engaged in their two years' course at the same time, they no sooner pass their examination than they are absorbed into the works of companies or private persons, at first as assistants, and only after some years' practice, as responsible managers. The end and aim of this school is thus distinct from that of Paris, where chiefly Government officers are educated. At St. Étienne the school fulfils the office of preparing, by a special course of instruction, suited to their after duties, the agents who are to take charge of the mining and metallurgical operations which form the root of manufacturing prosperity.

The pits of St. Étienne and Rive de Gier produce from 15,000,000 to 18,000,000 metric quintals per annum.

The price of coals was, in August 1855:—

	s.	*d.*	
For ordinary small coal	10	5	per ton.
For best quality do., smith's coals	12	6	„
For large coal, common	16	8	„
Do. do. best	17	6	„
Coke sold for the iron furnaces	20	0	„

At this time, however, the price was higher than usual, as in almost all the coalfields of Europe.

Mr. Smyth on Mining and Metallurgical Products.

Coal fields of Northern France; discovery of their extension.

Among the more suggestive specimens of coal were those of Escarpelle, in the Pas de Calais, to the company of which a gold medal was awarded. The researches for coal in the northern district are made under great difficulties. The productive measures are commonly overlaid by horizontal beds of newer rock, *terrains morts*, some of them saturated with water, which must be penetrated before the coal can be arrived at. The discovery of coal at Anzin in 1734, was the reward of eighteen years of expensive search, and the prolongation of the coalbeds thus proved towards the west, has for nearly a century been no farther determined. Enormous sums have been expended in boring and sinking, but in vain, till M. Dusouich, agent for the company of Escarpelle, taking a more scientific geological reasoning as his basis, pointed out a direction farther north than where others had been trying, and was rewarded in 1847, by the discovery which has greatly advanced the material interests of France.

As an example of the successful working of a Colliery Company on the largest scale, should be mentioned that of Anzin, near Valenciennes, which received a silver medal for the gigantic model representing their method of working, accompanied as it was by specimens of their coals, descriptions, and apparatus of every kind applied in their mines. This company employs 6,000 people at the pits, besides 1,000 in the workshops, &c., at the surface, and no less than 50 steam engines. The annual quantity raised by them, is 860,000 tons, the average price at the pits in 1854 was from 8*s.* to 12*s.* per ton, according to quality. The rapid increase in the production of this part of France may be seen at a glance in the following table:—

Coals raised in the Département du Nord.*

In 1800, 240,000 tons.	In 1847, 1,245,600 tons.
„ 1810, 231,800 „	„ 1848, 927,300 „
„ 1820, 238,700 „	„ 1850, 1,001,700 „
„ 1830, 323,800 „	„ 1854, 1,432,000 „
„ 1840, 836,000 „	

Another recent coal discovery made in France was illustrated by No. 33, the section of borings made at Landroff in the Moselle, which have proved the continuation of the valuable coalfield of Saarbrück, at a distance of above nine miles from the nearest pits.

* From an excellent report on the Arrondissement of Valenciennes, prepared for the Exposition, and edited by M. Edmond Pesier. As an approximation to English weights, I have supposed 10 met. quintals = to 1 ton, the exact value being 10 met. quintals = 2,204 lbs.

Belgium.

The annual production of the narrow, but deep and vigorously worked coalfield of Belgium, now amounts to 8,000,000 tons, of which Hainault alone furnishes 6,800,000 tons.

Belgian coal.

Situate, as many of the pits are, close to the frontier, a great export trade is carried on, and nearly two and a half millions of tons are sent annually to supply the rapidly increasing requirements of France.

Specimens of coal of various qualities were sent to Paris, some suitable to gas making, others for iron smelting. It is well known, that the seams suffer under the disadvantages of being thin, much disturbed, and often fiery, and the industrial spirit of the coal region deserves great credit for the good working condition and large produce of its mines.

The price of coals at Charleroi, in November 1855, was,—

For best large coals	19*s.* to 20*s.* per ton.
Intermediate (*gailleteries*)	14*s.* 6*d.* per ton.
Small (*menu*)	11*s.* per ton.

Prussia.

Coals of Prussia.

In Upper Silesia, Prussia possesses a coalfield which has long been extensively wrought. That of Westphalia has within the last few years been attaining a much higher importance than of yore, and appears destined, from its great richness and the presence of iron ores which are now largely raised, to play a considerable part in the supply of central Europe. In both of these, private enterprise is allowed a much freer scope than formerly, the Government only keeping up a system of inspection, which has reference chiefly to the safety of the men.

The coalfield of Saarbrück, on the other hand, is worked by the State, and although capable of great development, being very regular, and one of the richest known for thickness and number of seams, it produces only a limited quantity of about 1,200,000 tons per annum, a great part of which is exported into France.

The two latter districts, only, contributed an excellent series of specimens, mostly of large size, and exhibiting various qualities.

Mr. Smyth on Mining and Metallurgical Products.

The official returns of coals raised in Prussia in 1853 and 1854 are :—

Mining Division.	1853. Tonnen.	1854. Tonnen.	Value at Pit.	Price per Tonne.	No. of Workmen.
			Thalers.	s. g.*	
1. Tarnowitz -	7,850,164	8,650,273	2,004,607	7	9,873
2. Waldenburg -	2,243,757	2,484,842	921,774	11	3,417
3. Eisleben -	182,036	196,919	155,315	$23\frac{2}{3}$	556
4. Ibbenbüren -	291,767	242,876	133,215	$16\frac{1}{2}$	650
5. Bochum -	5,329,462	6,312,592	2,889,559	$13\frac{3}{4}$	10,302
6. Essen - -	5,402,012	7,037,904	3,130,985	$13\frac{1}{6}$	9,025
7. Düren - -	2,314,786	2,767,405	1,604,658	$17\frac{1}{2}$	4,963
8. Saarbrück -	5,164,181	6,363,463	3,069,800	$14\frac{1}{2}$	9,787
	28,688,165	34,056,274	13,909,913	$12\frac{1}{4}$	48,573

The *Tonne* is $7\frac{1}{9}$ Rhineland cubic feet, or 4 cwts.

In 1852 the quantity raised was 25,788,268 tonnen.

In 1854 there was also raised of lignite 12,566,852 tonnen, making a total of 46,623,126 tonnen of mineral fuel, or 9,324,623 English tons of 20 cwts.

Austria.

Coals of Austria.

An admirable report was prepared under the superintendence of the Hofrath William Haidinger, for the Exposition of 1855, to afford a general view of the conditions of occurrence of all the minerals of the Austrian empire. The statistics of the subject were, however, not given.

The amount of mineral fuel raised in Austria has increased in a very rapid rate ; it is probably much understated in the following official returns :—

In 1823	-	-	120,884 tons.
„ 1830	-	-	188,062 „
„ 1840	-	-	422,696 „
„ 1848	-	-	850,000 „

And has now advanced to about 1,500,000 tons.

A small portion of this only is extracted from the true coal measures, which make their appearance at Pilsen, Radnitz, and Schlan in Bohemia, Rossitz in Moravia, and Reschitza in the Bannat, Hungary. A large quantity of excellent coal is raised from the Lias formation, at Fünfkirchen and Steierdorf in Hungary ; and still more fossil fuel in the

* 30 Silver groschen = 1 thaler = 3 shillings.

shape of *lignite* or *brown coal* is obtained from the tertiary deposits scattered over many parts of the Austrian dominions. This is a kind of combustible in the successful application of which to manufacturing purposes the Austrians have led the way.

A spirited manufacturer of Vienna, M. Miesbach, contributed a goodly show of his productions in Hyde Park in 1851, when the annual quantity of coal raised at his various works was 137,500 tons.

In 1855, when he exhibited again largely, his annual amount of coal extracted from localities in Austria Proper, Styria, and Hungary, amounted to 200,000 tons.

In Austria wood is still of such primary importance that little attention, comparatively speaking, has been bestowed on her coalfields. Some of them, however, which are most advantageously situated, as those of Fünfkirchen and the Bannat, with reference to the navigation of the Danube, deserve to be worked with a system and appliances more in consonance with those of the larger metallic mining districts of the country.

Spain.

Coals of Spain.

Although Spain is a country producing a very small amount of coal in proportion to her capabilities, an excellent collection was forwarded to Paris, consisting of no less than 114 specimens, mostly from the Asturias, and many of them of excellent quality.

According to the *Revista Minera*, published at Madrid, the quantity produced in 1854 was,

Coal and lignite - -	2,425,500 quintals.
Coke - - - -	488,500 „

A much larger amount than this is required in the country, and though the coal deposits are numerous and rich, such is the want of industrial energy and of good internal communication, that the deficit is made up by importations from distant countries, mainly from England; and it would appear that the quantity imported has increased from less than 2,000,000 quintals in 1849, to nearly 5,000,000 quintals in 1853.

Lignite.

Several of the other European countries exhibited isolated specimens of mineral fuel, most of them of the class of *lignite* or *brown coal*; and it is interesting to observe the occurrence of this substance, which is slowly growing into economic importance, at so many points in the tertiaries around the Mediterranean basin. Southern France, Italy,

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Styria, and Greece sent examples. It has been discovered by the French in the province of Oran, Algeria; and fragments of the same mineral found their way from Turkey, where its occurrence, especially in the Lebanon range, and between Constantinople and Varna, ought ere this, for special purposes and when wood is deficient, to have become an object of value.

Model of a French coal mine.

Coal Mining.—Among the objects which attracted the attention of visitors to the *Annexe*, none seemed to excite greater interest than the section of the workings of a coal mine as conducted at Anzin, represented on the grand scale of one-fifth of the true size. The special difficulties of the locality were admirably shown, the steep inclination of the seam, the contortion of the measures, and the necessity for timbering every part of the workings. The machinery for lowering the coal in the inclined planes, and for winding it up the shaft, were also well planned and executed. Still the mode of working was a simple one, well known to miners, and the very expensive model was rather adapted to captivate the public, than to present any improvement or subject for study in the processes.

Excellence of an English model, showing various modes of working.

There was but little to compete with it from other countries. Our English division was very inferior in this respect to its prototype of 1851. But there was one model (No. 15) by Mr. Wales, of Hetton, very little appreciated, although plain as it appeared, it exhibited a series of the most important modern improvements in the art of arranging and ventilating subterranean works, and taken in connexion with the giant character of the collieries to which they are applied, was far more usefully suggestive than its popular rival.

This model was divided into ten compartments, which represented,—

1st. The system of working coal in *panels* or districts.

2nd and 3rd. New panels in progress.

4th. A panel fully opened, and the ventilation so arranged that the pillars can gradually be removed.

5th and 6th. Improvements in the panel system, by which the pillars are extracted as early as possible after first opening; the ventilation being so arranged that a portion of the men may safely use candles whilst the others are obliged to employ Davy lamps.

7th and 8th. Modifications of the method of working by *long wall.*

9th. The Leicestershire mode of working by long wall, and

10th. The Derbyshire method, in which the coal is attacked in a long line of 300 or 400 yards.

An epitome was thus given of the result of long experience and study on the part of our most able colliery managers, by means of which two great national objects are sought to be attained; viz., increased security to the men, and diminished proportion of waste of that valuable store, which we are so rapidly exhausting.

Improvements in carriage underground.

Mr. Reid, of the Pelton colliery, exhibited (No. 14) a model of the arrangements employed for underground traction by means of stationary engines. Here again was a proof of the activity and scientific progress of our practical coal-viewers. In no part of an extensive colliery was improvement more needed, than in the transport along the subterranean roads, where the cost of carrying a given weight for a given distance was incomparably higher than at the surface. Within a very few years a method has been perfected by which the horses of a colliery, sometimes 60 or 80 in number, are replaced by a few small underground steam engines, which, giving rapid motion to an endless rope, bring to the shaft trains of from 20 to 30 waggons from distances of some hundreds of yards or even a mile.

Good example of a Belgian colliery.

From Belgium were exhibited drawings of the engine and apparatus used for raising coal at the well managed colliery of the Grand Hornu, near Mons. The engine has two cylinders of 75 centimetres diameter with a stroke of 2·13 metres: it acts directly on the drum, and a small auxiliary cylinder enables the engine-man instantaneously to turn on the power of steam to the brake in case of any accident. The waggons or tubs are carried, eight at a time, up and down the shaft in cages of wrought iron, and a very simple arrangement is adapted both underground and at the surface by which they are simultaneously run in and out of the cage from stages at four different levels. The machine is thus enabled, with two ropes, to wind as much as 1,000 tons per diem, from a shaft of 468 metres in depth.

Condition of the colliers.

The ventilation of the workings of this mine is very good, and the safety of the workmen otherwise well provided for. It is, however, somewhat repulsive to English feelings to find that females are still employed here underground. With this exception, perhaps, the conduct of the coal owners to their work people is deserving of study and imitation on the part of our countrymen. Instead of being regarded an unaccountable, *pariah* caste, as our colliers are too often

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considered, they are well cared for at the surface, lodged for the most part in excellent houses built by the company, have good schools placed within their reach, and are so encouraged by careful supervision, that, although they receive, like our own men, a very high rate of wages, they are raised above those habits of intemperance which are the bane of most of our coal districts.

Mechanical ventilators.

Ventilation of Coal Mines.—From various causes, which I need not here particularize, much attention has been bestowed in France and Belgium on mechanical methods of producing a ventilating current, in contra-distinction to the method by furnaces, commonly employed in England. Several machines were exhibited intended for this purpose.

M. Fabry's ventilator (Belgium, No. 3) consists of two broad wheels of three teeth each, which work closely into one another, within side pieces, in such a manner that, when revolving in one direction, they force the air downwards into the shaft above which they are placed, and when revolving in the opposite direction, they exhaust the air. It is a machine of the greatest simplicity, there being no joints to get out of order, and no high velocity requisite to produce the desired effect. I visited the first which had been established, at the Grand Buisson near Mons, and learned that during six years scarcely any repair had been needed. The machine is capable of passing a current of from 24,000 to 30,000 cubic feet of air per minute, and although so recently invented, no less than eighty of them are now in action at various coal mines in Belgium and Northern France.

M. Lemielle exhibited a ventilating machine of great ingenuity, in which a drum rotating excentrically within another, drives, by means of feathering vanes, a current of air admitted on one side of the external drum through an orifice in the other. It is evidently capable of forcing a large volume of air, but from the great velocity it imparts to the air on one hand, and from the number of joints upon which its action depends, on the other, it appears—although erected at several collieries—to be scarcely well suited to an application, where an occasional stoppage or fracture may produce such serious consequences in a fiery mine.

The useful ventilating machine of Mr. Struvé, of Swansea, was represented by a model, unfortunately classified under the head of "Pharmacy and Medicine." It has been worked with great success at several coal mines in Wales, and where a mechanical agent is desirable, it appears to be one of the machines for this purpose most deserving of consideration.

Modified forms of safety-lamps.

Safety Lamps.—Numerous modifications of the Davy lamp were exhibited, especially by the Sunderland com-

mittee, including some of those lamps where reliance is placed on a glass cylinder.

It is well known that two objections to Davy's safety lamp are its insufficient light and its insecurity when exposed to a rapid current. These have been obviated in many of the newer lamps by the substitution of a glass cylinder for a part of the wire gauze; but a fear of the breaking of the glass, either by an accidental blow, or by the fall of water on its heated surface, has hitherto militated against their adoption in England.

Belgian safety-lamps.

The Belgian Government, on the report of a Commission of Mining Engineers, sanctioned the use of four lamps only, viz., those of Davy, Mueseler, Boty, and Éloin.*

Mueseler's lamp is well known to miners, and may be styled *par excellence*, *the* Belgian lamp, since most of the Belgian coal miners are of opinion that in this the question of a good and safe lamp is solved; and as respects the apprehended danger from trusting to the glass, they have but one practical answer—there are nearly 18,000 of these lamps daily used in Belgium, yet no case of accident has been traced to the fracture of a glass!

Éloin's is another glass lamp, which from the arrangement of the wick gives a better light than any other, though from its facility of extinction, it requires to be carried with special care.

M. Arnould, of Mons, exhibited a simple method of fulfilling another requisite, viz., the locking of the lamp, to prevent the top from being removed by an inconsiderate collier. A thin pin of lead is passed through a hole in a screw which connects the two portions, and before being given to the collier, receives a stamp, which any attempt to remove the top must disfigure or destroy.

Mr. Mackworth, Government inspector of coal mines, contributed (No. 257) several modifications, partaking more or less of the principles involved in the above lamps.

Prevention of accidents from breakage of ropes.

Parachutes and Safety Apparatus.—To obviate the frightful consequences of the breaking of the rope by which the men are raised and lowered in the shaft of a colliery, various apparatus has been devised which was exhibited in 1851 by Fourdrinier, by White and Grant, of Glasgow, and two or three others. Continental mining engineers were, some of them at the same time, and others since, engaged on similar inventions, and in 1855 no less than nine such parachutes were deposited by France, Belgium, and Austria.

* These safety lamps, as well as those of several other English inventors, may be seen in the Museum of Practical Geology, Model Room, west wall.

The apparatus of M. Fontaine (France, 1158,) consists of two strong iron arms with teeth at their extremities, which in the normal state pass up and down freely between the wooden guide rods ; but by the breakage of the rope a spring is released, and they fly outwards, abutting against the sides and supporting the cage, to the upper part of which they are attached. It may be argued against it, as against most of the similar inventions, that reliance has to be placed on a spring which is apt to deteriorate, and that its action tending to displace or break the guide rods is not of a secure order. But it demands respect from the fact of its having been worked successfully for several years in some of the pits of the Anzin collieries, and of its having saved, since 1851, no fewer than 33 men from certain death. It possesses also, as do the English inventions, a means of detaching the cage from the rope in case of *overwinding* against the pulleys at the top of the shaft, a fertile source of accident in England as well as abroad.

On a somewhat similar principle is the *parachute* of M. Machecourt, of the Décize collieries, Nièvre, in which the play of the crossed levers is assisted by counterpoise weights. This with its wrought iron cage, and two large coal waggons was exhibited in full size.

Apparatus intended to fulfil the same purpose by springs being brought into action to clamp the cage on the sides of the guide rods were exhibited by several parties, the most remarkable being,—

1st. M. Jacquet, of Arras, in the Pas de Calais, in full size.

2nd. The Coal Company of Douchy, Lourches-les-Valenciennes, a small model of simple construction.

3rd. The collieries of Blanzy (Saône et Loire), (France, 15); apparatus full size, closely resembling that of White and Grant.

4th. That of Boisseau, or Büttgenbach, (Belgium, 154,) for which a kind of ladder with strong iron staves, 40 centimetres apart, is placed on opposite sides of the shaft. On these staves the bars, released by a spring on the breaking of the rope, find a resting place. The inventor has since modified this apparatus by releasing two pair of bars, one at some distance below the other, in order to lesson the shock which would be caused by the possible fall of so great a distance as 40 centimetres.

Although no safety apparatus was exhibited by England, the adoption of a means to prevent accident has not been neglected by British coal miners. Within the last five years

several lives have been saved by the application of White and Grant's invention at certain Scotch, and by Fourdrinier's at some English collieries. But the opinions of practical men are much divided on the subject. The obvious tendency of such machines is to induce parsimonious owners to work their ropes for too long a time, and careless workmen to neglect their due overhauling. None of those hitherto introduced appear to be simple enough, and great risk and expense have been incurred in consequence of their acting when not required, and stopping the cage in its descent. Some of them at certain of our midland collieries, have after trial of some months been again abandoned, and it is still a question whether constant and careful examination of the rope, and frequent replacement is not the best preventive against accidents.

Machines for raising men from the mines.

It would be unjust towards an active and liberal coal proprietor, M. Abel Warocqué, of Mariemont near Mons, and to a very important principle, were we not to devote some attention to the beautiful model (Belgium, 155,) of an apparatus recently erected by him for raising and lowering the men.

The miners in metalliferous districts have been always accustomed to pass up and down the shafts by means of ladders, those of the collieries are raised and lowered by the rope employed at other times for winding coals. On the score of humanity and economy both these methods are highly objectionable, especially when the depth of the mine becomes considerable.

Objections to the usual methods.

Under the first head it is sufficient to remind the reader that metallic miners suffer so severely from the toil of climbing the ladders, that a premature death awaits the great majority. It has been ascertained that in Cornwall 61 per cent. of the miners die from pulmonary complaints, of which, as well as disorders of the heart, the climbing is the main source. In coal mines, the total number of fatal accidents in shafts is very great, a portion only being due to the breakage of the rope or chain, whilst others are caused by collision and other mischances, which often occur in those pits where the system of cages and guides has not been adopted.

The loss, under the economical view of the subject, is extremely heavy, even considered apart from that entailed on the community by the destruction of so many workmen, on whom numerous families depend for subsistence.

Many of our metallic mines are between 1,000 and 1,800 feet in depth, and so great is the exhaustion consequent on ascending by ladders, after working in a high

temperature, that it very soon tells upon even the youngest and strongest men.

In a mine of 1,200 feet deep we may estimate the time of descent at half an hour, of ascent at one hour.* A great loss of time is occasioned with a large body of men, beyond that actually employed in climbing, by the waiting for the descent or ascent of those who first start, although this may be modified by suitable arrangement for the commencement and ending of their work. But the hour and a half of fatiguing exercise must necessarily be subtracted from the available day's labour of the men, and this amount of dead loss to the mine owner is variously given at from $\frac{1}{6}$th to $\frac{2}{5}$ths of the working force.

Taking it at $\frac{1}{5}$th, and the average value of the daily labour of 400 men at 2*s.* 6*d.*, we have $6d. \times 400 = 10l.$ as the daily, and 3,000*l.* as the annual loss in a single mine.

It must be observed that in copper, tin, and lead mines the miners are distributed at various depths, so that the above result would have to be modified according to the proportion of men who, in any given case, were employed at the shallower levels.

The wasteful expenditure of labour upon the ladders has not escaped observation in Cornwall, but the expense of lowering and raising men by the rope appears to have been insufficiently looked to in the colliery and ironstone districts.

Here again the loss of time in actual waiting at bank or at the pit bottom is a serious item; but if we limit ourselves only to the consideration of the length of time occupied by the winding engine in dealing with its human freight, we find that a very large sum is expended in conveying the men to and from their work.

A shaft of the above depth, 1,200 feet, may be traversed by aid of the excellent winding gear applied at many of our pits in one minute; but a smaller rate of speed is desirable when men are upon the rope, and double that time will not be too much, even when the best apparatus is in use. We shall have then, in a mine, as before, with 400 men, the

Time of journey - - - -	2 minutes.
Time for getting in and out - -	2 minutes.

or four minutes for every load, and supposing that eight, men may ride at once, $4 \times \frac{400}{8} = 200$ minutes are required for the descent, and as much for the ascent, or upwards of

* The time, as well as the degree of physical suffering to the men, will depend partly on the ventilation of the mine and partly on the judicious construction and placing of the ladders.

six hours, during which the winding engine and its attendant are rendered unavailable for raising mineral.

Invention of the Fahrkunst.

In 1833 the *Fahrkunst*, an apparatus for raising the men by the reciprocating action of two rods, like pump rods, was devised by M. Dörell, a mining officer of the Hartz, and it was soon afterwards applied to several of the very deep shafts of that district. The rods were in some cases of wood, in others of wire rope, and some have recently been constructed of rolled angle iron.

Its introduction in England.

Shortly afterwards, the exertions of the Polytechnic Society in Cornwall gave birth to a very similar "man-engine," the first of which was erected at the Tresavean mine in 1842, whilst others have been placed at United Mines, Dolcoath, and Fowey Consols, enabling certain localities to be worked which must have been abandoned but for its introduction.

Its great success.

The success of these machines has been so pronounced, both as regards economy to the masters and the preservation of the men, that they have within the last twelve years been erected in several other of the ore-bearing regions of the Continent, and also in some of the coal districts, more especially at the Centrum mine, in Westphalia; Gewalt, on the Upper Ruhr; Anzin, in France: Seraing, in Belgium; and Mariemont, the latter being represented in the model before us.*

Details of the machine at Mariemont.

In the *fahrkunst* of Mariemont there is nothing new as regards its principle. The rods make a stroke of three metres, at the rate of eight strokes per minute each; a man is consequently raised six metres at each double stroke, or 48 metres per minute = 157 feet.

On each of the platforms fixed to the rods is room for two men, who will thus be conveyed up or down 1,200 feet in less than eight minutes, and each platform being successively occupied by two men, the whole of the 400 may be lowered to, or raised from their work in 32 minutes. Doubling this amount for the passage both ways, the engine would thus be occupied only one hour and four minutes in the day.

M. Warocqué's *fahrkunst* is erected in the midst of the mines called La Riunion, Ste. Melanie, L'Étoile, and Ste. Henriette, and by one shaft of 540 metres = 1,771 feet, no less than 700 men and boys pass daily to and from their work in the four collieries. The steam engine has a double acting cylinder of 90 cents. diameter, and is estimated at

* Very careful calculations on the efficiency and cost of these machines, as compared with one another and with the ordinary methods of travelling in shafts, are given in a paper by Mr. Dieck, in "Karsten's Archives," vol. 124.

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120 horse power, although it generally works at about 40. The rods weigh 18 tons each, and are counterpoised against one another by a hydraulic apparatus. The cost of the *fahrkunst*, with its engine, boiler, and boiler-house is given at 1,650*l.* for 150 fathoms, and it has been calculated that the comparative expense of conveying 250 men for this depth is by this machine 483*l.* per annum against 3,021*l.* by the ordinary method of the rope.

The proved safe working and the economy of this apparatus are facts which speak for themselves.

One objection made to these machines is that they occupy either the whole or part of a shaft, which might be devoted to the purpose of drawing coals or other mineral to the surface. An apparatus was exhibited in Hyde Park, in 1851, by M. Mehu, of the Anzin collieries, in which the same rods were made available for raising coal as well as the men. It has been at work for several years in the Davy shaft at Anzin, a pit of only 70 metres in depth, so that its apparent complexity has not prevented its application in practice. M. Warocqué had a similar apparatus attached to the model of his *fahrkunst*, which, as far as a model could do, executed its office admirably, lodging the ascending and descending waggons at the end of every stroke on little tappets ingeniously fitted to do their work. But the system has not been carried out on the large scale ; the very numerous joints exposed to wear and tear, and to clogging with rust and small coal, render the real working amid all the roughness of a mine so dubious that we cannot as yet hail this addition as a practical improvement.

Washing of small coal.

Before quitting the subject of fossil fuel it may be noted that there are coals in certain districts which, by the presence of iron pyrites or of shale, &c., are unfitted for many purposes, and particularly for smelting. At the works of Baron de Burgk, in the Tharand Valley near Dresden, a process of washing the small coal was established before 1826, which, on the principal of floating off the specifically lighter coal from the heavier impurities, rendered available an otherwise waste product. M. Bérard, a former student of the School of Mines at St. Etienne, received the Council medal in 1851 for a large machine, recently invented by him, to effect the same object. In Bérard's apparatus, which is worked by a steam engine, an elevator, or endless chain with buckets attached, raises the coal to a classifier or set of griddles, where it is sorted into sizes. The different classes are then passed by the machine on to jigging sieves placed over chests of water,

to which a rapid up and down motion is given by a piston. The coal floats up and away over a ledge in the front of the tray or sieve, into the waggon placed to receive it, whilst the layer of heavy impurity, which is allowed to accumulate to a certain height as a bed on the sieve, keeps shifting by a slight inclination of the frame towards a slit or valve, whence it is continually discharged.

Continuous jigging machine, applied to dressing of ores.

There is here, then, an important principle introduced, that of the continuous action of the jigging sieve, an apparatus hitherto so expensive from the amount of manual labour that it requires. As the machine was not new since 1851, I should not have occupied space with its description, but that the latter part of the arrangement is one deserving of much attention from our miners, very few of whom are aware of the numerous applications which have been made of the same principle to the dressing of metalliferous ores by Mr. Rittinger, of Austria, and others. M. Rudolph Vogl, of Joachimsthal, (Austria, No. 8) exhibited a constant-action jigging machine of this kind; and a model was also sent by the Hartz.

Bérard's coal-washing machine is in operation at numerous mines in France and Belgium; also at Fence Houses, at pits near Whitehaven, and some other places in the north of England. It may with a moderate power be made to wash 100 tons of small coal a-day; and its effect could not be better seen than in the well-arranged exhibition of rough and washed samples from the French coal mine of Décize; nor its value better illustrated than by the fact that some coals, too rank with pyrites to be used for anything, may be crushed and washed, and ultimately produce a fair coke for smelting or locomotive purposes.

Fifth Section.

Pig and Wrought Iron.

Smelting and manufacture of iron.

Among the most remarkable phenomena of the present day is the gigantic development of the iron trade. Within a very few years, the daily extension of the use of this prince of metals to the varied requirements of civilized life, and especially its enormous distribution in the network of railways, which now embraces so many and such distant lands, has given an impetus to the production of iron, which has been responded to more or less by all European countries.

At the Exhibition in 1851, the pre-eminence of Great Britain in this branch of art was placed in the strongest

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light, many of the continental nations having been there but imperfectly represented. At Paris, in 1855, the example of what had been done at the former gathering, and the propinquity of many of the continental works, led to the far more complete illustration of the manufacture by foreign nations, whilst our own productions naturally occupied a less prominent position in comparison.

In this, one of the most important elements of national prosperity, a march of rivalry and competition among several of the greatest of the European nations has arisen, the actual progress of which it is in every point of view desirable to note and to measure.

Importance of not limiting judgment by objects in the Exhibition.

It would be utterly unworthy the nature of the subject, as well as futile as regards the aim of such an examination, to rest contented with a mere comparison of the objects presented at an exposition, even when accompanied by statements of price, the criterion of buyers and sellers at a given moment. Considering the extraordinary history of the manufacture of iron within the last century, its present progressive condition, and the variety of sources upon which its economy depends, we must, like the poet—"with forward and reverted eye,"—not omit to observe the past, if we would gain some clue to the probable future.

The difference as regards most of the manufactures, between a Universal Exposition and a shop should be, that whilst the latter supplies us only with the elements upon which we may found a present commercial transaction, the former presents us with suites of the raw materials, with documents relating to their abundance and mode of working, with samples from the different processes of manufacture, and statistics illustrating its history. When these data are wholly or in part added to the important item of price, we have the foundation for that philosophical view of the subject, which connects it on the one hand with the phenomena of nature, and on the other with the varying phases of human society. From the difficulty, however, of fulfilling all the conditions of a complete exhibition, any attempt at a general review must be aided by other means than those obtainable within its walls, and must necessarily remain imperfect.

Great Britain.

England, Scotland and Wales produce together about half the total quantity of iron yielded by all the nations of the earth. Such high pre-eminence, however, is but of recent date, and not a hundred years have elapsed since we were

dependent on Russia for a great portion of the iron required for home consumption.

For centuries Great Britain produced important quantities of iron smelted with charcoal, but as increasing population spread over the land, and wood became dearer, the production began to decline. The first propounders of the method of smelting by coal, met with such opposition at the hands of the masters, and riots on the part of the workmen, that it occupied about a century to make the first step of the great stride which has now reached to the farthest corner of Europe; and it was only in 1740, when the production of British iron had sunk to 17,350 tons, made in 59 furnaces, that the use of fossil fuel began to be largely applied.

History of British iron manufacture.

Three great improvements have since that time originated in this country, and enabled us rapidly to take the lead of other nations:—

1st. The improvement of the steam-engine by Watt, as adapted to the working of mines, and the blowing of the furnaces.

2nd. The invention by Mr. Cort of the cheap process of manufacturing wrought iron by *puddling* and subsequent *rolling*.

3rd. The application of the hot blast, first introduced by Mr. Neilson at furnaces in the neighbourhood of Glasgow.

The two former of these most valuable innovations were perfected during the war, and gave to Britain, fortunate in her isolated position, the opportunity of firmly establishing a manufacture which could with difficulty be attempted by any of the nations of the continent, whose territories and commercial relations were subject to frequent disturbance.

British ores of iron.

Britain possesses in a greater degree than any other country, that first essential to the cheap production of iron, abundant stores of coal and ore situate in close proximity to one another. Scarcely any of her extensive coal-fields are destitute of a remunerative quantity of the interstratified ores, termed clay ironstone and blackband; whilst in most of the foreign iron-producing countries these are either very poor, or as in some cases, have been much neglected. The United States, which alone exceed, and that in a great degree, the coal area of Britain, possess these convenient ores in very limited quantity, and draw the chief supply for their smelting furnaces from a distance.

This source of the superiority of our country was most imperfectly represented in 1855, but the very full and well-described collection of Mr. Blackwell, in the Exhibition of 1851, supplied us then for the first time with a conspectus

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of the raw material of all our different districts, and a means of comparing it with that which was assembled from other lands at Paris.

The rapid progress of the manufacture in Great Britain will be apparent at a glance, from the production of pig iron in the following years :—

In 1740	. .	17,350 tons of iron.
1788	. .	70,000 pig iron.
1800	. .	180,000 „
1825	. .	600,000 „
1830	. .	678,000 „
1839	. .	1,248,781 „
1851	. .	2,500,000 „
1854	. .	3,069,838 „

The enormous make of 1854 was the produce of about 555 furnaces, only two of which still work with charcoal, the remainder all employing coke or raw coal.

British exhibition of iron.

The iron-works of Great Britain were represented by No. 30, a collection from *Bowling*, near Bradford, in Yorkshire, celebrated for the excellent quality of its iron; by No. 31, a series from *Farnley*, a work lately established in the same district; and by No. 8A, the contributions of 53 different exhibitors arranged upon one stand, under the superintendence of Mr. Bird, himself a juror in another class.

This excellent collection was very limited in extent as compared with the French, Belgian, Prussian, and Austrian, and contained but few large objects. Nevertheless, the principal varieties of pig and wrought iron were well represented, a judicious selection having been made in each of our iron producing districts.

The specimens were in most instances fair samples of the goods as manufactured for the trade. Some few of those *tours de force*, which we were inclined to expect only from our foreign rivals, attested the ambition or the spirit of the producers; among these were railway bars, rolled to the respective lengths of 75 and 80 feet, and weighing nearly a ton each, the manufacture of one of which involved the knocking away of the side wall of the mill in which it was rolled.

Among the more complete or suggestive collections may be mentioned those of—

Dowlais, South Wales.—A good series of the ores employed, with pigs, bars, and portions of ordinary and of Barlow rail. This work, possessing 18 blast furnaces, is remarkable for its arrangements and for the numerous experiments which have been made for the improvement of the processes. The largest furnace, probably, in the world was not long since erected here, measuring 50½ feet in height,

19 ft. 10 inches as the greatest diameter at the boshes, 12 feet diameter at the tunnel-head, and with a round hearth of five feet diameter. As yet, however, its performance has not answered expectation.

Shelton, North Staffordshire.—A section of the new pits was exhibited illustrated by a series of specimens, and by photographic views of the machinery and apparatus. Pigs and bars were shown, and a fine plate for ship building, of 17ft. 3 inches long, 4ft. wide, $\frac{5}{8}$ths thick, and 14 cwt. 2 qrs. 14lbs in weight. These were the only specimens from a district remarkable for producing, in the very uppermost part of its coal measures, several regularly stratified beds of ironstone similar to the blackband, though locally termed *red mine*, *red shag*, and *Bassymine*, each bed being in different places from 2 ft. to 6 ft. in thickness. The coals most suitable for smelting purposes occur only in the deeper part of the coal measures. Nine blast furnaces and a well-arranged new mill and forge attest the magnitude of the establishment.

Derwent Company, Consett and Bradley, near Gateshead.—This large group of works, numbering no less than 18 blast furnaces, is established on the outcrop edge of the Northumbrian coal-field, where it would probably have been starved for want of ore, but for the opportune discovery of the ironstone of Cleveland in Yorkshire, which is carried this long distance by railway to meet the excellent and cheap coke produced by the lower seam of coal. Among its principal objects were a rail of 75 feet in length, and a ship plate rivalling the above mentioned, being 22ft. 3 inches long, 54 inches wide, $\frac{5}{8}$ths thick, and weighing 1,544 lbs.

Weardale Company, Tow Law.—An instructive series of the coals and iron ores used, among the latter the *sparry iron* (carbonate of iron), Spatheisentein, which occurs in the neighbouring lead mines as a *rider* or associated mineral with the lead ores. A very good quality of iron is occasionally here produced, and Mr. C. Attwood, the manager, regrets that the comparative scarcity of the sparry ore allows him to employ it only for the higher-priced irons. The mills and forges of the company are at Tudhoe, not far from Durham, at some miles distance from, though connected by rail with, the smelting works. They may be cited as some of the most powerful and best arranged in the country, and a great variety of bars, some of them bent double without a flaw, spoke for the superiority of the produce.

The *Butterley Company*, Derbyshire, possessing at Butterley and Codnor Park seven blast furnaces, exhibited an excellent series of pigs, bars, boiler plates, patent railway spoke iron, and some large tires bent both hot and cold.

Tredegar, by a rail of 80 feet in length, and *Rhymney* by a Barlow rail above 52 feet long, contributed proofs of the powerful machinery which is employed in some of our larger rolling mills.

Colebrookdale, in Shropshire, sent a fine series of its well-known castings in iron, which, however, being the result of second fusion, passed to the adjudication of another Jury.

The *Mersey Ironworks*, at Liverpool, exhibited specimens of taper iron bars, prepared by them for ships' knees, for railway points, &c., and manufactured by an ingenious process of rolling, which has reduced by nearly one half the price of articles so rapidly acquiring greater importance.

Ebbw Vale contributed a series of its productions, among which the more remarkable were the rails fitted to one another with several kinds of fish joints, already widely recognized as introducing increased steadiness of motion, and safety in railway travelling.

The *Gospel Oak Works*, *Blaenavon*, *Millington and Co.*, of Tipton, *Ystalyfera*, *Bagnall and Sons*, of West Bromwich, and *Mr. Whitehouse*, of West Hallam, were all characterised by particular excellencies of their products.

Among the Scotch works, *Monkland* was particularly distinguished for the variety of its forms of wrought iron, including various patterns of rail and angle iron. *Dundyvan*, *Muirkirk*, *and Kinneil* were represented by a very good collection of pigs, rails, and bars. The chief aim of many of the smelting establishments of Scotland is the production of foundry pig, which, as is well known, is there produced at a less cost than in any other district in the world. Several

Scotch iron works.

Mr. Smyth on Mining and Metallurgical Products.

of these works were represented each by a set of pigs of the various qualities produced; and, in order to do them justice, it was needful to associate with the specimens their vast commercial importance, and the grand scale upon which the operations are conducted. Among them, *Gartsherrie*, the property of the Messrs. Baird, is one of the most remarkable objects in the world. On either hand a row of eight great blast furnaces, of 48 feet in height, and 17 feet diameter at the boshes, a canal down the centre, coal-pits and railways at the back, evince not only the amazing power of production, but the attention which has been bestowed on the most economical method of arranging the details of this huge establishment.

			Quantity exported to United States.	France.
The make of Scotland was, in	1830,	37,500 tons.	—	—
„ „	1840,	241,000 „	—	—
„ „	1850,	630,000 „	57,500 tons	10,500 tons
„ „	1851,	775,000 „	80.000 „	10,600 „
„ „	1852,	770,000 „	100,070 „	18,000 „
„ „	1853,	700,000 „	151,300 „	20,000 „
„ „	1854,	796,600 „	115,300 „	31,200 „

The further reduction of the French duty in January 1855 would greatly facilitate the introduction of Scotch pig iron into France.

The discovery of the *blackband* ironstone by Mr. Mushet, in 1801, was the first step to Scotland's greatness in the iron trade. But, as usual, so great was the prejudice to be overcome, that in 1825 Monkland alone was employing that ore. The introduction of Neilson's hot blast in 1829 accomplished a saving of 2½ tons of coal for each ton of pigiron produced; but when its temperature was increased from 300° F. to 600° F. in 1833, and raw coal came to be used as fuel, as much as four tons of coal were saved in the smelting of a ton of pig iron from the ordinary ores. With the *blackband* the quantity of fuel is even farther reduced, only 35 cwts. of coal being needed to make 1 ton of grey pig. The economical process of calcining this stone without additional fuel, and thus producing an ore containing 60 or 70 per cent., coupled with its ready fusibility, have rendered the application of this substance one of the most valuable ever made.

The chief bed, the Airdrie, or Mushet's blackband, is situate in the upper part of the coal measures, about 120 feet below the main, or 8 feet coal, and is only from 14 to 18 inches in thickness, resting, over very large areas, on a bed of coal about 5 inches thick. Its consequent rapid exhaustion gave rise, a few years ago, to well-grounded uneasiness respecting the future of the Scotch ironworks. But a second bed, the *Slatey Blackband* from 1 to 3 or 4 feet thick, has been discovered about 100 fathoms deeper in the measures, and is now worked at *Shotts*, *Summerlee*, and *Coltness*. Besides these, some bands of inferior thickness are found, associated with coal seams in the still lower measures, corresponding to the carboniferous limestone of our southern regions, and with some beds of nodules, which also occur in that low position, are capable of furnishing large supplies for many years to come.

The thin sheet iron and tin plate of Britain, which have obtained a just celebrity in commerce, were exhibited by *Knight and Co.*, *of the Cookley Works*, by *Abercarne*, the *Osier-bed Works*, *Cwm Avon Company*, and *Pontypool*.

Lias ore of Yorkshire.

One of the most startling features of the development of our iron manufacture has been the discovery and the application, within half a dozen years, of the stratified ironstone which occurs in the central part of the Lias formation in the Cleveland district in Yorkshire. This extraordinary seam, which averages over a large tract no less than 15 feet in thickness, is most admirably placed for working, cropping out along the hill sides above Middlesbro', and in the valleys between that place and Whitby, and inclined at a very low

angle, so that it may be extracted at an almost nominal cost. Where not oxydised it presents a peculiar greenish hue, and frequently an oolitic structure, which distinguish it from any ore of iron which had before been worked in Britain. It appears to contain, on the average, about 30 per cent. of metallic iron, and the value of the discovery may be inferred from the fact that already above sixty blast furnaces are fed from this prolific source. Of these many have been erected in close proximity to the mines or quarries, from which the ore is lowered by railway inclines, and receive their fuel from the coking coal districts of Western Durham; whilst others, which had been intended for the smelting of the sparse coal-measure ores of Northumberland and Durham must, but for this happy event, have been involved in gigantic ruin.

It would be premature to pass an opinion on the character of the iron obtained from this new source. In some cases, where a fair admixture of the rich hœmatite of Whitehaven is employed, very good results have been obtained, but in other instances report hints that the quality hitherto produced is not likely to advance the fame of British iron.

The only representative of this great new branch of the iron trade was a group of specimens sent by Mr. Samuelson, of the *South Bank Works*, Middlesbro', among which the portions of ore were so minute as to escape general attention.

France.

Production of iron in France.

On the continent of Europe France occupies the first place as an iron producing country. Deriving her supplies of iron ore in great part from superficial deposits spread over a vast tract of country, she had, till within a few years ago, almost confined the manufacture to the localities in which wood was available as fuel; and it is only within about thirty years that the employment of coal has commenced, after the English example, to stimulate the smelting of iron by the great extension consequent on the reduction of expense.

General progression.

Dufrénoy gives, in the following table, a view of the advance in the production of pig iron from 1819 to 1847.

	Coke Iron. Tons.	Charcoal Iron. Tons.	Total Tons.
1819	2,000	110,500	112,500
1830	27,103	239,258	266,361
1840	77,063	270,710	347,773
1847	239,702	282,683	522,385

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From the *Journal des Mines* for 1855, we have the production of the succeeding years given in metrical quintals of 1,000 kilos.

	Coke Iron.	Charcoal Iron.	Total.
1848	1,901,109	2,823,320	4,724,902
1849	1,628,664	2,513,249	4,141,958
1850	1,761,335	2,295,196	4,056,531
1851	1,986,998	2,471,083	4,458,081
1852	2,593,034	2,633,400	5,226,434

The second table shows that a period of five years was required to make up for the blow inflicted on commerce by the revolution of 1848, and that it was not till 1852 that the production of iron again equalled what it had been in 1847. During the last three years, a period of great prosperity, the ironworks of France have been so extended that the total annual production will probably amount to 700,000 tons.

It will be seen from the first of the above tables that the total quantity of iron made in France has been quintupled in about thirty years, the rate of increase being nearly the same as in Britain from 1825 to 1854. But it is not thus that the development of the French iron trade is to be judged. In France, as in England, the main dependence of the country for ordinary iron must be on that produced by coke and coal, and in this department the rate of progression has been far more rapid. In the same thirty years, during which the production of charcoal iron has been little more than doubled, the amount of coke-made iron is now 100 times what it was thirty years ago!

Special increase of coke-made iron.

Even thus the requirements of the country are far from being satisfied, and large amounts of pig as well as manufactured iron are imported from France and Belgium. Whether the French iron masters will be capable of still farther advance must depend on the price of ore and fuel, the scale and arrangement of the works, and the skill and economy which they can bring to bear on the processes.

France has suffered from defective means of transit.

It is well known that France is not so fortunately circumstanced, generally, as England in the collocation of her repositories of coal and iron ore; the latter, indeed, is in some districts obtained at quite as cheap a rate as with us, but the means of communication have, till lately, been very defective, and the physical constitution of most of the coalfields operates against any great reduction in price of the fuel. Yet even under these heads great advances have been made; railways and improved methods of working the coal are introducing a great source of economy. As to the

magnitude of the establishments, and the skill which conducts them, some idea may be formed by a glance at their productions in the Exposition.

French exhibitors of iron.

The works of *Decazeville* (Comp. des Houillères et Fonderies de l'Aveyron, France, No. 57,) has been established with its ten blast furnaces, and proportionate mills and forges, by the energy of its director, M. Cabrol, in a district where all was new. Clay ironstones, very similar to the English, occurring both in nodules and beds, are among the ores used. The productions of the work, in pigs, bars, ordinary rails, Brunel and Barlow rail, were all of excellent quality and finish; for the rolling of the latter, two steam-engines of 140 horse-power each are employed, and in a diagram were shown the "train spécial" or carriage, and the gearing by which these heavy rails are rolled alternately in opposite directions.*

No. 77. Jackson et Comp., of *Rive de Gier* and *Vierzon*, are greatly developing the value of the minerals of the coal-field of St. Etienne. It contains, however, but little clay ironstone, and a great part of the ore is brought from La Voulte in the Ardèche, near the banks of the Rhone, where there are three beds of red iron ore, each from 1 to 5 metres thick, and containing fossils of the lower oolite. This house employs about 2,860 work-people, and their productions are distinguished by superior quality; among them might be observed some of the hammered iron plates made for the floating batteries, and weighing 3½ tons each; tires for driving-wheels for locomotives, up to 4 metres in diameter, made without welding, and with the bearing portion of steel; some very fine rolled iron bars, weighing up to 1,272 kilo.; hammered iron cranks and axle for the "Eylau" man-of-war, of 1,000 horse-power, the one piece of forging weighing 2,570 kilo.; and a piston rod of cast steel of four metres length, and 1,040 kilo. weight.

The abundant use of steel was remarkable in the productions of this company, most of which therefore fell under the observation of Class XV.

45. Boigues et Co., *Fourchambault* (Nievre), exhibited excellent cast water-pipes of three feet in diameter, which have successfully competed with the English at Madrid. A good specimen of the fineness of their castings was a very large sheet of only three millimetres thick, stated to be cast direct from the blast furnace. A garrison gun-carriage of cast iron was well executed, but appears, although to some extent warranted by use, to be in principle a wrong adaptation of material to its end. Surely a substance so brittle cannot practically be considered suitable where real service is contemplated.

46. Bougueret, Martenot, et Co., *Châtillon-sur-Seine* (Coté d'Or), a work numbering no less than 36 blast furnaces, and selling annually about 66,000 tons of cast and wrought iron. The ordinary rails, rolled iron girders, and other bars are all of very good quality.

79. Lallemand, frère et sœur, *Uzemain* (Vosges), although not a large work, is notable as producing the best iron in France.

101. *Montataire* (Oise), contributed a fine series of rolled girders up to 19 metres in length, and plates of which one was 8·50m. long, 1·50m. wide, 15½ millimetres thick, and 1,550 kilos. in weight; another 14·80 m. long, 7 mm. thick, and 509 kilo. in weight.

102. The iron company of *Denain and Anzin*. These works, erected in the coal-field before alluded to, form one of the best examples of the rapid strides made in introducing the English methods of smelting with coke, and of puddling and rolling. They contain five blast furnaces, and 15 puddling furnaces, employing 1,800 men.

In 1804 only one furnace was at work, employing charcoal.

In the years 1846-7, 9,938 tons of pig-iron were produced with 2 furnaces.

1850–1,	4,998	„	„	1 „
1854–5,	28,482	„	„	5 „

* I am informed by Mr. C. May, C.E., that in 1853 he sold the patent right for employing these two methods to the Compagnie du Chemin de Fer du Midi, to be worked at Decazeville and Commentry.

Mr. Smyth on Mining and Metallurgical Products.

103. Comp. of *La Providence, at Hautmont* (Nord). The rolled girders for employment in buildings were specially observable among the products of several of the French works. In the collection from Hautmont, many different patterns of T and double-headed girders were shown, the larger being nearly one foot high, by 4½ inches broad in the head, and 25 feet in length. Some exhibitors, as *Dupont et Dreyfuss*, had rolled them to as much as 50 feet in length.

One of the most complete and instructive collections in the Exhibition was that of *Creuzot*, a very large work situated advantageously in the coal-field of that name, and deriving its ores by an inexpensive water-carriage from the jurassic and the tertiary deposits of the Berry. Wrought iron of every variety was furnished in the series, including among the heavier work some of the thick plates for floating batteries.

107. Madame de Wendel, *Hayange* (Moselle), contributed samples of various goods produced from the iron of her 16 blast furnaces. An important feature of this work is the late discovery, by boring, of the prolongation of the coal-field of Saarbruck towards the west, a result highly satisfactory to France, not only from the numerous and excellent seams of coal which characterize this basin, where it has been worked in Prussia, but from the fact of its being conveniently situated for the import of the abundant iron ores of the neighbouring departments.

It is interesting to observe among the sources of mineral wealth recently opened up in Algeria, that No. 442, the contribution of the mining and smelting company of *Alélick*, near Bona, contained pigs of African construction, of an excellent steely iron, from which samples of very good-looking steel had been manufactured in France.

New processes of M. Chenot for making iron and steel.

4486. A gold medal was awarded to *M. Adrien Chenot*, of Clichy, "for his remarkable collection of new and important facts, in an industrial point of view, particularly the rational and economical processes applied to the reduction of iron from its ores, and especially for the direct manufacture of various descriptions of steel."

This reward was voted after the Prussian and Austrian jurors and myself had left Paris, the remainder of the jury being persuaded, that M. Chenot had now brought his process to the point of being commercially valuable. The late M. Chenot, whose untimely death was the result of an accident after the closing of the Exposition, had for many years devoted himself to this particular branch of metallurgy, and had just arrived at the maturing of his plans on a large scale. His furnace is twelve metres high, and is charged with alternate layers of iron ore and small charcoal. The fire plays through a chamber outside the body of the furnace, the grate (which is so formed as rather to distil than to burn the coal), being placed rather below the middle of its height. The charge in passing down the furnace is first warmed, then calcined, and lastly, under the action of the carbonic oxide is reduced to a spongy state, the *éponge métallique*. In this state it would take fire and burn, if oxygen were admitted, so that great difficulty has been experienced in removing the sponge after reduction. On descending past the fire-grate, it gradually cools, and on reaching the bottom is extracted by an ingeniously contrived trap. After this

preparation, the two processes of *compression* and *fusion* are required, and it is only by these that the gangue, which in the ordinary process passes off in the slag, is eliminated.

M. Chenot calculated that the production of a good quality of steel, including an ample margin for profits, would cost but 40*l.* per ton.

M. Le Play, the Commissaire-Général of the Exposition, whose metallurgical acumen is known throughout Europe, did not hesitate to pronounce M. Chenot's process the greatest metallurgical discovery of the age. Arrangements for working it on a large scale were about to be made both in France and England towards the end of 1855, but till the statistics of some such application are obtainable, we are justified in entertaining doubts of its commercial importance.

Prussia.

The principal centres of production of coal and iron in Prussia are three in number; viz., Silesia, Westphalia, and Saarbrück. In the former, the introduction of iron smelting with coke took place sixty years ago; but in consequence of the bad material of the common roads, and want of other means of communicating with more populous districts, the progress of the manufacture was less rapid than might have been expected. The clay ironstones of the Silesian coal fields are good, and the secondary formations of the neighbourhood afford large quantities of a poor brown peroxide ore. The furnaces are built on a large scale, and well arranged, but their make is only from 60 to 70 tons per week each.

Iron manufacture of Silesia.

Silesia, however, is now able, from the impetus given during the last ten years by the introduction of railroads to make sufficient bar and rail iron for inland consumption, of a quality superior to the ordinary English and Belgian bars, which used to be imported. The plates for boilers, &c. are said to be still deficient in quantity and quality. This distant province was but feebly represented in the Exposition, although the collections (63) of Count von Hohenloh-Oehringen from *Slawentzitz*, and (85) Count Renard, of *Gross-Strehlitz*, exhibited a variety of irons of excellent quality.

Rhine Prussia and Westphalia, which during the last few years have made a gigantic advance, contributed a far more complete series of their productions.

Of Westphalia.

In 1853, the total quantity of iron produced in Prussia had increased 172 per cent. over that of 1834, the date of the foundation of the *Zollverein*.

Mr. Smith on Mining and Metallurgical Products.

The same increase of the quantity of coke-made iron over that smelted with charcoal, may be observed in Prussia as in France; in 1854, the proportion of coke pig was 52, and of charcoal pig 48 per cent. With the extended application of mineral fuel have sprung up several large works, founded on the English model, which are doing much to alter the character of the Prussian iron trade; and a glance at the particulars of some of these will throw a light on the importance of the step which has thus been made.

Smelting of blackband ironstone.

A gold medal was awarded to the company of *Hoerde* in Westphalia, No. 108, as being the first work in the country which has utilised the *blackband* ironstone. This valuable mineral has been discovered in the coal-field of the Ruhr since the Exhibition of 1851, occurring in several seams of from two to three feet in thickness. For above two years difficulty was experienced in the treatment of this new substance; but it has been fully vanquished, and Hoerde is now producing an excellent iron from blackband alone. Only three years ago, the produce of about 40 blast furnaces was annually imported from Belgium and Britain for conversion into bar and sheet iron, but since this great discovery no less than 45 blast furnaces of the modern large dimensions have been commenced or completed.

Prussian exhibitors of iron.

At *Hoerde* four blast furnaces are at work, making 157 tons (at 20 cwts.) each per week; two more are proposed to be erected.

Each pair of furnaces have a blast engine of 140 horse-power, with 6 boilers of 57 feet long and 5½ feet diameter, heated each by the waste heat of six coking ovens.

At the mills and forge called *Hermannshütte* are fifty puddling and thirty-eight reheating furnaces; and the rail-rolls are worked by a horizontal engine of 120 horse-power. Fourteen steam engines are here employed, having thirty-three boilers *all* worked by the waste heat of the puddling furnaces; and, including the blast engines, an aggregate of 1,048 horse-power is thus obtained by the most economical means.

Six puddling furnaces are devoted to the manufacture of *puddled steel*, which has been largely employed for railway purposes, especially for the bearing surface of the rails. Experiments have been made in the Cologne and Minden railway on tyres of iron, puddled steel, and cast steel, from which it resulted that the latter were the most economical as well as the safest.

The total quantity of puddled steel produced in Prussia in 1853 was 57,055 cwts., at a cost of 14*s.* 3*d.* per cwt.

In the construction of the Hoerde furnaces, trial was made of the refractory materials of Belgium, Westphalia, and Scotland; and the Scotch fire bricks from Garnkirk which cost *in loco* 105*s.* per 1,000, appear to have been much approved of.

In September 1855, the price of coal at the pits was five silver groschen per *scheffel*, (about 10*s.* per ton), coke pig-iron 36 to 38 thalers (5*l.* 11*s.*) per ton. It is satisfactory to be able to add that, the total value of the products for the last year amounting to above 2,000,000 thalers, a dividend was declared at the rate of 10⅔ per cent.

96. The *Phœnix* Company, Eschweiler Aue, is one of those large associations which the rising spirit of enterprise has called into successful existence. They work twelve blast furnaces placed as follows:—

At Ruhrort, 4 coke furnaces, yielding each 6,500 tons of pig per annum.
„ Borbeck, 4 „ „ „ „
„ Kupferdreh, 3 „ „ „ „
„ Langheck, 1 wood furnace, for puddled steel, 1,200 „

They employ about 2,000 men as ore miners and waggoners, and work the following ores:—

98,000 tons red oxide of iron, from Nassau; irregular beds in the calcareous slates, between Wetzlar and Limburg.
36,000 „ brown oxide of iron of the Rhine and Ruhr; masses in the ancient limestones.
16,000 „ magnetic oxide, Nassau, irregular deposits in calcareous schists.
8,000 „ sparry-iron of the Rhine and Moselle; the rider of the veins of lead and zinc ore.
6,000 „ earthy iron of Siegburg, occurring with alum slates.
4,000 „ do. of the Ruhr collieries, *blackband*.
2,000 „ meadow ore of the Rhine, "phosphoric hydrate" of Duisburg,
170,000 „ with an average yield of 40 per cent.

The total horse-power at the furnaces and forges is - 2,517 horses.
Number of workpeople employed at do. - - 6,380
Produce of the company's coal mines - - 215,000 tons.
„ of blast furnaces - - - - 71,200 „
„ of manufactured iron - - - - 32,000 „

A great variety of the products was exhibited; among others a rolled round bar for shafting, of 7·015 metres long, and the extraordinary weight of 3 tons 5¾ cwts.

The work of Messrs. Jacobi, Haniel, and Huyssen, at *Sterkrade* and *Oberhausen*, is also an important establishment, especially for the construction of machinery. It exhibited, among other objects, a plate of 2,510 lbs. weight, measuring 25 feet 2⅞ inches in length, 5 feet 1 inch in breadth, and half-an-inch bare in thickness, very clean rolled.

The fine castings in iron, for which Prussia has long been celebrated, were placed in the 16th Class; among them none more beautiful than those of Count Stolberg-Wernigerode, from his picturesquely-situated work at Ilsenburg, at the north foot of the Hartz mountains.*

The total production of pig iron in the Zollverein is thus given by Oechelhauser:— Production of iron in the Zollverein.

	Prussian Centner or Cwts.	
	1850.	1853.
1. Prussia - - - -	2,623,883	4,099,932
2. Bavaria - - - -	328,846	485,978
3. Saxony - - - -	197,789	175,637
4. Wurtemberg - - -	153,484	124,465
5. Baden - - - -	106,107	102,351
6. Kurhessen - - -	67,745	87,923
7. Hesse Darmstadt - -	104,532	144,770
8. Brunswick - - -	67,460	79,890
9. Nassau - - - -	293,112	398,276
10. Luxemburg - - -	131,920	280,000
11. Thuringia - - -	70,001	75,000
12. Small States - - -	78,900	72,235
Total - - - -	4,232,778	6,126,457

In 1854 there were imported into the Zollverein of pig and scrap iron, paying one sh. per ton duty, 2,376,747 cts.

* Examples of these unrivalled castings, as taken from the mould, may be seen in the Museum of Practical Geology.

Mr. Smyth on Mining and Metallurgical Products.

Belgium.

Production of iron in Belgium.

The effects of the revolution of 1848 were in no country more marked than in Belgium, as a check to the progress of the iron trade. In the two years during which the political horizon was more or less disturbed by the events taking place in France, the value of the annual production of iron was reduced nearly one half. The following table is derived from the official report of M. Devaux, Inspector-General of Mines :—

	Value of smelted minerals.	Value of iron produced.
1845	51,061,188 francs	35,868,669 francs
1846	71,280,129 „	52,633,623 „
1847	76,541,297 „	58,003,137 „
1848	46,083,219 „	32,341,304 „
1849	46,947,187 „	30,459,681 „
1850	49,784,457	—

The return to prosperity in 1850, when the quantity of pig iron produced in Belgium amounted to about 144,450 tons, has been followed up by several years of such enlarged operations that the present annual amount may fairly be estimated at 200,000 tons.

Belgian exhibitors of iron.

The great work of *Seraing*, near Liége, (No. 28a.) occupies the first rank, and has been remarkable for the successful introduction within the last five years of the method of producing steel in the puddling furnace. This description of steel, manufactured at a low price, has been largely applied to railway and machine purposes, and has the merit of being produced from mineral fuel, and the common ores of the county, instead of the expensive Swedish and Russsan iron which were formerly employed. It has not yet, however, been found suitable for the manufacture of files and finer implements.

Chatelineaux (22), *Marcinelle and Couillet* (26), *Sclessin* (27), and *Grivegnée* (27a) were some of the large works of the Belgian coal-fields of Charleroi and Liege, which contributed very complete collections of their productions. The blast furnaces have not at these works been fitted with the means of utilising the waste gases, as in France; but it is very generally the case, that the waste heat of the coking ovens is economized for the boilers of the blast engines. At the extensive and well-arranged establishment of *Conillet*, for example, near Charleroi, four furnaces are blown with no other fuel used for power than the waste heat from a range of coke ovens, connected by a great tube or main.

Newly employed red ore.

(20.) *Ougrée.*—This establishment exhibited particularly the products of a new and very important ore, the *mine rouge*, which till lately was considered unworkable, chiefly from the large amount of phosphoric acid which it contains. It is a bed of pisolitic red peroxide, regularly interstratified with the mountain limestone in the district of Huy and Namur, as accurately represented in the map of M. Dumont, belonging to his *Système Condrusien*, and from its great extent it bids fair to play a chief part in the production of this district of Belgium.

Among the more remarkable productions of the Belgian ironmasters were the sheets, *tôles de fer laminé*, exhibited by the Messrs. Delloye of Huy, and Remacle of Liége. These sheets were some of them produced with coke, others with charcoal; some simply rolled, others subsequently polished; but their admirable uniformity of thickness and smoothness of surface placed them at the head of all similar objects in the Exhibition; and it says not a little for the manufacture, that these sheets are even exported to England. The price given, for June 1855, was 35 francs per 100 kilogrammes (or 200 lbs) for unpolished, and 45 francs for polished sheets.

Belgian sheet iron.

Austria.

In consequence of the peculiar structure of many parts of this empire, the iron works are generally small, and situated in spots more or less difficult of access among the mountains, most of them dependent on the wood which clothes the slopes in their vicinity, or which may be floated to them down the rivers. In Bohemia and Moravia the English method of treating the ores with mineral fuel has been adopted; whilst in Styria and Carinthia the chief attention of the ironmasters has been directed to economising the processes by which iron of high quality is obtained by charcoal from the sparry and hœmatite ores with which those provinces abound.

Austrian iron works, their peculiar character;

During the last few years a process has been perfected by which wood, peat, and lignite are distilled, and their gases employed in the puddling and reheating furnaces with great advantage. In a preparatory chamber the wood is completely dried, and converted by slow heating into a fuel which possesses such special metallurgical properties, that Le Play, in his detailed description of the process, has termed it *ligneux*. When worked for the puddling furnace, the gases of this fuel are projected over the bridge upon the sole of the furnace, where they are met by a rapid current of heated air driven through a tuyère; and thus a material which in its raw state could only be used for the old process of treating small quantities at a time, is employed for puddling on the large modern scale.

employment of gas furnaces.

The gas furnace (*Gasofen*) is stated to occasion an economy in fuel of 50 per cent., and has been copied from the Austrian model in various other states.

Citing the "Noricas enses" of Horace as a proof of its celebrity in early times, we may note that the iron of the Austrian Alps bears a high reputation, and that for

Good quality of Austrian iron.

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certain purposes, as particularly for scythes and sickles, it claims a superiority over all others. The limited quantity, however, in which it is produced, and its comparatively high price, have enabled English iron to be largely introduced, when, as for the railways, a great amount has been required within a short time.

The total quantity of pig iron made in Austria in 1854 may be estimated at 225,000 tons, and that of bar iron at 150,000 tons.

The Austrians exhibited no specimens remarkable for size or weight, but an extensive series of the bar irons made for actual trading purposes, and among them many which were interesting from the peculiar methods by which they were produced. The following were some of the more notable :—

Austrian exhibitors.

39. A gold medal was awarded to Count Ferdinand Egger, *Lippitzbach*, and *Feistritz*, Carinthia, for the first adaptation, after expensive trials, of the gas process to puddling. At these works $3\frac{9}{10}$ cubic feet of wood suffice when thus employed, for 1 cwt. of puddled iron.

10. Baron Rothschild, *Witkowitz*, Moravia, examples from a large work established in 1828, which, with its mines, employs 4,400 men, and turns out 3,000 tons of machinery per annum.

26. The company of the Radmeister, *Vordernberg*, 10 blast furnaces, smelting the sparry ores, and yielding pig of high quality.

28. *Innerberg*, near Eisenerz, Imperial Works; 7 blast furnaces; great variety of products comprised in the Exhibition.

30. Mayr, of *Leoben*, produces the best puddled bar in Austria; also puddled steel, cement steel, &c. Total annual value of products, £150,000.

38. Baron von Dickmann, at *Lölling*, Carinthia; the ores at this work are sparry iron, containing 48 to 50 per cent. Each furnace makes 105 tons of pig per week. The charcoal is of the spruce fir (*Fichte*), and 70 lbs. of charcoal make 100 lbs. of iron. The blast is heated to 200° R. The produce was, in 1854, 13,000 tons.

47. The widow of Baron Zois, at *Jauerburg*, Carniola, exhibited specimens of the productions of her work, which contains two blast furnaces and eight reheating fires. As at several of the works above-mentioned, steel is also made, and at this place in particular, the use of peat or turf has been advantageously introduced into the iron manufacture.

70. Badoni, of *Lecco*, near Milan, also employs peat in gas furnaces at his well-arranged rolling mills.

Sweden.

Swedish production of iron.

It is almost superfluous to remind the reader that Sweden excels among the iron-producing countries less for the quantity than for the admirable quality of the irons which she produces. Especially for the purposes of steel-making are large amounts annually imported from the Baltic into England and France.

It appears that in 1850 the total amount produced was 4,011,304 cwts. of pig, from 220 furnaces.

Swedish ores.

The ores chiefly employed in Sweden are the magnetic oxide, and oligist ore or crystalline peroxide, to some pecu-

liarity in which (whether chemical or physical it is at present difficult to decide) the value of her steel irons is mainly due. The remarkable irregular repositories from which they are obtained* appear to be worked with such activity as to leave no room for a great extension of operations, except in the case of some of them, as Gellivara, which lie remote from the sea or convenient channels of communication.

One cause of the excellence of the Swedish bars, and of the confidence which can be reposed on the quality indicated by their brands, is no doubt the extreme care bestowed, 1st, on the selection of the ores, some of which only in each locality are proved to be suitable for particular purposes; 2nd, on the elimination of all impurities, both from the ore and charcoal. The furnaces are of small dimensions, blown in general through one tuyère only, with air either cold or moderately heated; and the process throughout is not characterised by that economy in fuel which distinguishes the modern charcoal furnaces of France and Austria.

At the Exposition might be seen a good series of their fine crystalline ores, the peculiar pale green blast-furnace slugs, and of hammered and rolled bars, mostly with bright granular fracture, many of them twisted and tied up into knots, with sharp edges perfectly unbroken. Among the principal exhibitors were the works of—

Eckman, of *Lösjefors;* Baron Tam, of *Osterby* (Dannemora iron); *Motala; Finspong,* where they cast iron guns direct from the blast-furnace; Clason, of *Furudahl; Garpenberg,* near Fahlun; and Zethelius, of *Surahammer.*

Spain.

Spanish irons.

This country, so rich in ores, and so long the producer of small quantities of excellent iron, smelted by the old methods direct from the ores, still yields but a very small produce. In 1828 blast-furnaces, on the modern system, were first erected, at *Rioverde,* near Marbella, and several works are now employing mineral fuel.

According to the *Revista Minera,* 1855, the annual amount produced in Spain is—

Bar iron -	-	- 575,400 cwt.
Cast iron -	-	- 161,200 „

The corps of artillery have established at Truvia a particularly well-arranged work, with two coke blast-furnaces, whence a series of good products was exhibited.

* See a recent description by Durocher, Ann. des Mines, 4th ser. tom. 15.

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Excellent bars and some tools were also contributed by the *Compañia Minera Lenense Asturiana;* and specimens of castings, and of iron obtained by direct conversion, were sent by several other companies.

Italy.

Iron of Italy.

From the valley of Aosta, and other localities in Piedmont and Savoy, examples of pig, wrought iron, and steel were contributed.

Tuscany exhibited fine specimens of the classical ore of Elba, and it is a curious fact that this—

"insula inexhaustis Chalybum generosa metallis"

has recently begun to export its rich ore to our distant coalfields.

The quantity raised in 1854 at Rio, in Elba, was	60,000 tons.
Of which were smelted in Tuscany	25,000 „
And exported to Naples, Genoa, France, and England	35,000 „

In 1855 the amount sent to England had greatly increased.

Summary on the Iron Trade.

General deductions on the iron trade.

A careful review of the coal and iron produce of different states, as illustrated in the Exposition of 1855, impresses upon us certain facts relating to the chief nations of Europe which require a few concluding remarks. The iron trade of America was not represented in Paris, and most of its chief points of interest and importance have recently been described by Mr. J. Wilson, in his Report on the Exhibition at New York. Extensive as is the manufacture of the United States, it yet appears that, from the high standard of wages, and the remote position of most of the United States coalfields from the cities of the Atlantic sea-board, it will be long ere a material check will be given by internal production to the import of iron from Europe.

United States not represented.

Great Britain's pre-eminence.

Enriched in a wonderful degree by nature, and favoured by the energy of her people, Great Britain maintains, as she has done since the end of the last century, a surpassing pre-eminence in the production of the ordinary classes of iron, which, after all, form the great bulk of what is demanded by commerce. The applications of pit coal, and of the puddling furnace and rolling mills, were matured during a period when our internal quiet contrasted favourably with the oft-repeated convulsions of continental coun-

tries; and thus at once all our competitors were distanced in the race. The later introduction of the hot-blast has so added to the economy of the first processes, that within sixty years the average weekly production of a single furnace has, owing to the combined improvements, advanced from 30 to more than 100 tons. Many of the larger furnaces of South Wales, Scotland, and Staffordshire yield even as much as 200 tons per week continuously.

Great increase of make.

But, in the meanwhile, the demand for cheap iron, no less for internal consumption than for exportation, has had a deteriorating effect on quality. In cast as well as in wrought iron is this change observable. The sea-service mortars employed in the late bombardment of Sweaborg tested severely the strength of the most careful castings of the best firms, and a superiority is stated by some officers to have been shown by the mortars cast in 1815 over those of 1850–5. Our iron ordnance, generally, is proved to possess less power of resistance than that of most of the other iron producing countries;* and it is almost needless to speculate upon the decisive results which might have been sooner obtained, and of the great national saving which must always ensue, if we could ensure a material capable of better resisting the strain of heavy charges and rapid firing.

Deterioration of quality.

One great cause of the difficulty in obtaining a quality suited to these special purposes is doubtless to be found in the scarcity of wood fuel in Britain. But with the certainty of works being established in some of our colonies, as in India and Nova Scotia, it will be important to observe, that the old methods of charcoal smelting on the Continent have been very greatly improved; and that, in place of the minute quantities of pig which used to be yielded upon this system, a make amounting to from 70 to 100 tons per week is now obtained from some of the furnaces above-mentioned in France, Styria, and Carinthia.

As regards wrought iron, it is notorious that if bars or sheets of really good quality are required, there are only a few works in the kingdom to which we can apply; and which compensate by the higher price of their goods for the smaller quantity produced. Again, since the general extension of the railway system, comparative experiments have been made in foreign countries on the strength and

* The tables compiled by the engineers at Woolwich on the results of action, and of their ordinary process of proof, establish a secure foundation for comparison with the proving establishments of other countries, and point to the necessity of endeavouring to improve the quality of those castings which are to be employed for special purposes.

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wear of their own and of British irons, which have been unfavourable to the latter.

Cheapness not alone to be regarded.

To all such instances it will be retorted by a large class, that cheapness is the great element of commercial success; and that upon our low prices and enormously increased production we may safely take our stand. It would, I am aware, render a report far more popular with the majority, if it were to insist mainly upon the great pre-eminence of Great Britain in the iron manufacture, and the success with which she is enabled to undersell every other country; but such an Exhibition as that of Paris is not to be regarded as a mere warehouse and list of prices current; and a few observations on the progress made by foreign nations will be regarded with interest by our ironmasters, as the parties chiefly concerned. Moreover, the public at large is seriously interested in the question, not merely because inattention to quality may by degrees check our trade, but because every day increases our dependence on this most valuable of metals. There are few individuals, in this locomotive age, who will not feel that their safety may be compromised by the breakage of an axle, the failure of a plate in a steam ship, or the yielding of a girder bridge,—to say nothing of the risk occasioned to certain classes by want of strength in chain cables, wire ropes, boiler-plates, cast pillars, and machinery.

Progress of foreign countries;

France and Prussia are our chief rivals in the production of iron for ordinary purposes. Their annual amounts are immeasurably behind our own; but the mere numbers of tons would lead us to false conclusions. The great fact is, that these countries (and we might add Belgium and parts of Austria) have within the last few years firmly established the English methods, which we, under great advantages, introduced during the late war. The result therefore in advance, as compared with our own, must be judged according to the quantity produced by similar processes, and this will be found to have increased in a very rapid ratio.

of France.

France, in despite of the higher cost of fuel, has so far lessened the expense of iron making that it has been feasible by degrees to diminish the import duties without injuring the ironmasters. Already, within twenty-five years, pig iron has been reduced to less than one third of its former price. The ores of iron are generally obtainable at a sufficiently low rate, and the means of intercommunication, which were long very deficient, are now so fast improving that it appears not improbable that in some districts of France the cost of making iron will ere long be reduced to

something much nearer the English standard; and many of the ironmasters expect to be placed in a few years in so firm a position as not to fear the concurrence which would be caused by free trade.

Employment of waste gases.

It is not surprising that with their wits sharpened by the high price of coal, the French have exceeded us in some branches of economy. Amongst others, the successful employment of the waste gases which stream from the top of the blast furnace merits attention. Messrs. Laurens and Thomas, established in 1835, at the works of Echalonges, the first steam boiler which was heated by the waste gases of the blast furnace; and what with their method, and that patented by M. Robin, the application of these gases is now almost universal in France.

These engineers exhibited a model, in one-twentieth scale, of a coke furnace with their hydraulic method of closing the chimney, the only mode they have found successful in collecting the gas.* By these means, at most works, sufficient heat has been obtained to work the blast-engine, as well as to heat the air, and a good deal over, which has been applied to the reheating furnaces, to lime burning, and the desiccation of wood. Contrary to the opinion of most furnace men, they hold that it is not good to allow the gases to stream too freely to the chimney, and that they should only escape under a certain pressure.

By the hydraulic method of closing, having a manometer, and using a valve opening to a high chimney, they have come to the conclusions, that, 1st, any amount of draught (*aspiration*) injures the working of the furnace; 2nd, a pressure of some centimetres of water is good for its action; 3rd, generally, pressure above tends to retain heat in the lower part of the furnace. They assert also that by the employment of this apparatus the make of the furnace is rather improved than deteriorated, a result entirely different from what has been obtained in parts of Germany and England, where other methods have been attempted.

The economisation of the waste gases has been successfully applied at Ystalyfera, at Ebbw Vale, and other neighbouring works in South Wales, but in central England, as in Belgium, the experiments hitherto made have proved unsuccessful, probably from the difference of the materials employed.

Another source of economy is the utilisation of the waste heat from coking ovens and puddling furnaces. This, as above indicated, is widely in vogue on the continent, but

* This model is now deposited in the Museum of Practical Geology, Jermyn Street.

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among our abundant stores of coals has been much neglected, although in some few cases, as at the fine rolling mills of the Weardale Company, at Tudhoe, it is in successful operation.

Importance of pure fuel.

The economical application of the gases, whether of the blast-furnace, or of fuel especially employed, has been already alluded to as being practised in Austria, Northern Germany, &c., and may be found available in a variety of cases. The impurity of much of our mineral fuel has long been recognised as a source of mischief. Lowmoor and Bowling ascribe chiefly to the unusually clean character of their coal the superiority of their iron. There have not been wanting attempts to remedy the evil by chemical treatment of the coal during the operation of coking; and Mr. Calvert's case of specimens, backed up especially by the excellent iron shown in the machinery of the Messrs. Platt, of Oldham, said much for his application of common salt in the production of a purer coke.

The due arrangement of the different parts of an extensive work, so as to obviate unnecessary carriage, has in most works not received the attention which is due to it; and the introduction of mechanical aids in heavy rolling, as by the methods of Charles May and M. Cabrol, ought greatly to diminish the amount of manual labour.

It has been presumed by many persons in this country, that the physical strength required for puddling would operate against competition, as regards that operation, on the part of the workmen of France and Germany. But besides pointing to the amazing progress actually made in those countries, as already indicated in figures, it may be added that I have been assured by professional Englishmen who have had opportunities of testing, that the French puddlers not only perform their task with the requisite strength and skill, but will often, in consequence of their regular and temperate habits, turn out a greater quantity of work per week than the majority of our own countrymen.

English processes established on the Continent.

What then are the final conclusions? The methods of manufacturing cheap cast and wrought iron have been transplanted to the continent. France has, since 1819, increased *one hundred and fifty fold* her production of coal-made iron; Prussia has, *by her new Westphalian works*, during the last five years been enabled to dispense with the importation of the produce of some forty blast-furnaces. We have no special appliances, no peculiar systems to keep us in the van, and our future pre-eminence in the iron trade must depend more than of yore on the skill and economy with which we employ the stores of material so bountifully

distributed through Britain. The spirit of association has been aroused in those countries, and has led to the formation of establishments on a scale unknown but a few years ago. Their workmen have had to learn their business, but are docile. Their agents and directors are, as a class, so much better informed than our own, that but for the practical energy of our own countrymen, we should on this head suffer severely in competition.

Good quality of foreign castings;

Among the articles exhibited at Paris were many which might invite attention to improvement in our metallurgical works.* Of the value of the cast-iron for strength, it is impossible to speak without a series of experiments more general than those by which ordnance has been tested; but for sharpness and beauty may be instanced some of the German castings, especially those of Count Wernigerode Stolberg; for surface and even for elasticity, those of Messrs. Boigues and Co., Fourchambault, who exhibited a large plate, described above, of little more than one eighth of an inch thick, cast direct from the blast furnace, yet having almost the appearance of a rolled sheet. The due choice of materials and regulation of the smelting process require, undoubtedly, more study than they have hitherto received in this country.

and of girders for building.

In rolled iron, one of the most remarkable productions of France, was the girder of T or double T section. These are manufactured by several of the French ironworks, as above enumerated, and, being produced at a low cost, about 16*l.* per ton, are very largely employed in modern architecture. It is, perhaps, rather the fault of our builders than of our ironmasters, that these simple and efficient beams should be so little known among us, for an analogous article has been prepared for iron ships in certain British rolling mills, as for example, at the Monkland works, where such beams, weighing from 11 to 18 lbs. per foot, are rolled to 40 feet in length.

In the department of sheet iron, nothing approached the perfection of the Belgian examples, especially those of the Messrs. Remacle and Delloye, whether we refer to those made from charcoal, or coke-iron, or those simply passed through the rolls, or subsequently polished.

Rails.

The continental rail-makers place great stress on the introduction of a harder quality of iron for the upper surface of the rails. Our own engineers appear to be some-

* I abstain from enlarging on the remarkable production of steel by Jackson and Co. of St. Etienne, Krupp, and others, since this manufacture was referred to another Jury.

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what divided in opinion on this head, a difficulty being experienced in so incorporating the different qualities as to prevent lamination and unequal wear. Many of the specimens, both German and French, offered however a very satisfactory appearance, and the farther extension of this principle by forming the upper surface of puddled steel, appears to be gaining ground.

Conclusions.

In magnitude of production and lowness of price we are at present unrivalled, and the task for the ironmaster in future will be to endeavour, by scientific treatment of his subject, to produce a superior article at the same or at a less expense. Our materials, practically inexhaustible, require, many of them, more skilful handling; our workmen need to be guarded against strikes and improvidence; and the greater part of our managers, energetic though they be, would be none the worse men for a better training in the principles of the operations which they conduct.

Sections Six, Seven, and Eight.

Metals other than Iron.

British production of copper.

Copper.—The production of copper in Britain, which was inconsiderable 100 years ago, rose rapidly from the beginning of this century to the year 1830, and has since that time fluctuated without attaining a much higher point.

The production of ore has nevertheless increased, from the average diminution of the per centage in the ores. The total produce of copper for 1854 is given as follows:—

	Tons.	Value.
		£
Cornwall and Devon, chiefly from 111 mines -	13,042	1,229,808
Wales, 8 mines - - - -	25	2,011
Ireland, 13 mines - - - -	1,124	128,053
Mines included in private contract sales -	5,426	593,434
Foreign copper sold at ticketings -	3,456	378,498
Total of copper produced in Britain -	23,073	2,331,804

This vast field of enterprise and manufacture was only represented by three exhibitors in the Exposition of 1855.

35. The *Great Devon Consols Mining Company* sent some large masses of copper pyrites, of which all that can be said is that, without them, British copper mines would have been entirely unrepresented.

34. Messrs. *Bankart and Sons* contributed a series of small specimens, illustrating the processes of copper smelting, that great industry which enables Swansea to regulate the entire copper trade of the world.

36. The *English Copper Company*, of Taibach, sent various samples of manufactured copper.

Copper mining, always hazardous, is in other countries as well as our own fostered by wise immunities, but the competition of foreign rivals has hitherto been inconsiderable.

French copper works.

France is endeavouring, in despite of her deficiency of copper mines, to render available her stores of coal in the coal-field of Alais, and of the north, to the manufacture of this important metal, and even to smelting it from its ores.

The house of *Figuéroa*, at Marseilles (116), and *Œschger and Co.*, at Blache St. Vaast, in the Pas de Calais (124), exhibited most remarkable specimens of copper sheets, bars, &c., and farther success is anticipated in consequence of the discoveries of copper ore which have been successfully followed up in Algeria. Among the latter were more especially notable the rich copper pyrites from Ténès, and from Milianah, and the gray copper glance or vitreous sulphide from Mouzaia.

The opening of the railway connecting Marseilles with the coal-fields may also bring to the French works the ores of Tuscany and of other Mediterranean localities.

France is, next to England, the greatest consumer of this metal, as appears from the amount imported in the year 1853:—

	Tons.
From Great Britain - - - -	3,581
„ Russia - - - - -	1,095
„ Sweden, Norway, and Germany -	121
„ Mediterranean States - - -	274
„ Turkey - - - - -	135
Total - - - -	5,206

Austrian copper.

Austria exhibited the productions of most of her mining districts. Among the collections of most interest were those from No. 87, *Agordo*, in the Tyrol, where the system of concentration by roasting in large piles renders it feasible

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to treat successfully ores which only contain two per cent. of copper. These works produce 200 tons of copper annually, besides 250 tons of sulphur, and 500 tons of vitriol.

117. The company called the *Waldbürgerschaft*, in Upper Hungary, is developing with great spirit the resources of that district. There are employed in this district, around Iglo, 6,940 workpeople, producing annually, besides iron, 600 tons of copper, 50 tons of quicksilver, and 10,000 to 12,000 marks (at half a pound) of silver.

Of the other countries which exhibited copper ores may be mentioned:—

Copper of Sweden;

Sweden, the producer of about 2,000 tons of copper per annum; good examples of ores and manufactured copper from *Fahlun* and *Widaberg*, the latter stated to be remarkable for its smelting processes, whereby only two parts of copper are left in 10,000 parts of slag.

Tuscany: rich ores from the very successful mine of *Monte Catini*, worked by Messrs. Hall, Sloane, and Co.

of Lake Superior.

The United States: a few specimens of the extraordinary deposits of native copper from the Lake Superior district. These mines, which occur in two groups at *Keeweenaw Point* and *Ontonagon*, were commenced in 1842, and for some years contended unsuccessfully against the unusual difficulty of having an ore too rich for economical extraction, the native metal being so tough as to render it necessary to cut it out with chisels. During the last few years the produce has been steadily increasing.

Year.	Tons of Copper.
1845	12
1846	26
1847	214
1848	461
1849	674
1850	574
1851	781
1852	795
1853	1,299

The amount for 1854 was estimated at 2,350 tons and for 1855 at 3,200 tons.

As usual, however, in copper mining, so also in this district, many of the mines have been eminently unsuccessful, and in some of them a very large capital has been expended without producing any return.

Tin, the oldest mineral product of England, was unrepresented at the Exposition, although the annual quantity produced in Devon and Cornwall, chiefly from 85 mines, of which the returns are given, now amounts to 8,747 tons of "black tin," or prepared ore, yielding about 5,947 tons of metallic tin, of the value of 690,000*l.* Tin produce of Britain;

It should not be omitted, that among the foreign possessions of Britain, two are likely to distinguish themselves among the comparatively few tin-producing countries of the world. The search for gold in Australia has led to the discovery of deposits of rich "stream tin," from which metallic tin has been produced in the colony. The Indian collection also contained ingots of tin from *Moulmein*, *Malacca*, and *Pahang*. of British Colonies;

Stream-tin stone was also exhibited from *Tucopah*, one of the south-western provinces of Siam, which is said to produce annually 22,000 *picals*, at 133 pounds, or 1,306 tons.

It was interesting to observe the close analogy of the tin-bearing rocks of other countries with our own. From the granites of Morbihan, France exhibited some fine specimens, magnificently crystallized. The veins of *Villedor*, *Pourmabon*, *Villaulan*, and *Lédo* appear to be the most notable. of France;

Spain exhibited ores and ingots of metallic tin from the mines "*Numantina*" and "*Clotilde*," in the province of Zamora. of Spain;

The district of the *Douro*, in Portugal, yields tin ore, hitherto but little explored, of which specimens were contributed, with an illustrative series of rocks, by Baron Forrester. As in Spain, the tin was derived from a granite with a white nacreous mica. of Portugal;

From Austria were sent instructive samples of the tin-stone which occurs and is largely worked in the north of Bohemia. The mines of *Schluggenwald*, which once produced 200 tons of tin per annum, now yield little more than 25 tons. of Austria;

In the Mexican collection were some partially-rounded pieces of tin ore, with a fibrous structure (the Cornish "wood tin"), from San Luis Potosi, accompanied by ingots of metallic tin. and Mexico.

Lead.—It is only within a few years past that the high position of Great Britain as a lead-producing country has Lead produce of Britain;

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been fully appreciated. The annual amounts for the last seven years have been as follows:—

Year.	Tons of Ore.	Tons of Lead.
1848	77,864	54,853
1849	86,773	58,703
1850	93,043	64,527
1851	101,964	65,110
1852	91,236	64,987
1853	85,043	60,969
1854	90,553	64,005

The amount for 1854 was extracted from 252 mines, besides the group included in Mr. Beaumont's mines, those of Derbyshire, and the Yorkshire valleys of Swaledale and Arkendale.

From these ores there were extracted in 1854, 562,659 ounces of silver, for a large proportion of which we have to thank the scientific investigations of Mr. Pattinson, for which the Council Medal was awarded to him in 1851.

The only illustration of British lead mining in 1855 was the series of specimens from Mr. Beaumont's mines in Northumberland, arranged by Mr. Sopwith, F.R.S.

of Spain;

Spain, so rich in other minerals, especially abounds with the ores of lead, specimens of which were contributed from *Carthagena*, *Almeria*, *Linares*, *Zamora*, and other localities.

The amount given in the "Revista Minera," 1855, is no less than 1,385,560 quintals, besides 159,950 quintals of galena. No statistics accompanied the numerous specimens in the Exhibition, but other estimates place the annual production of lead in Spain at 25,000 tons.

of France;

France possesses only a few lead mines working on a considerable scale, but these were well represented in the Exposition.

135. *Pontgibaud* (Puy de Dôme). These extensive mines are now worked by a mixed English and French company under the management of John Taylor and Sons, and are setting an example of legitimate and skilful mining which may prove very valuable to France. Established on a group of north and south lodes, crossing through granite in close proximity to the volcanic rocks of the district, they meet with a peculiar difficulty in the continual evolution of carbonic acid gas, which requires a powerful ventilation for its extraction; yet in the course of a very short time they have been brought into a satisfactory state of operation. They were illustrated by a good series of specimens, including a cake of silver weighing 404·5 kilogrammes, or 889 English pounds, being considerably more than either of those exhibited from our own works in 1851.

Pontpéan, near Rennes, *Alais*, *Vialar*, and *l'Argentière*, also contributed series of their contributions; and it is observable that, as remarked under the head of copper, the improved access to the coal-fields is now giving facilities to the establishment of smelting works, where the Pattinson process is employed for desilverizing, as that of Figuéroa at Marseilles, in which lead to the value of 200,000*l.*, and silver worth 64,000*l.* were extracted in the last year.

The mines of Kef-Oum-Theboul, in the province of Constantine, Algeria, exhibited, with their ores, pigs of lead, a cake of silver weighing 225 kilogrammes (worth 2,080*l.*), and an ingot of gold of the value of 1,200 francs. The assay of the silver produced here being, silver 994·80; gold 3·66.

Austria: The Hungarian districts* of *Schemnitz, Nagy-banya*, and the *Bannat* sent numerous examples of their products, as well as the mingled ores of lead, copper, and silver from which they were obtained, with instructive suites of the rocks with which those ores are associated. of Austria;

The beautiful and productive mines of *Przibram*, in Bohemia, now 360 fathoms deep, and employing 3,000 workmen, were represented in a particularly lucid manner, not only by well-selected specimens, but by plans and sections, and by diagrams expounding at length the modes of *dressing* or preparing the ores for the smelting furnace.

Ores and pigs of excellent pure lead were also sent from *Raibl* and *Bleiberg*, in Carinthia, at the last of which places several private companies are profitably employed.

Prussia: This kingdom possesses two centres of production of lead and zinc; the one on both banks of the Rhine, in Westphalia and towards the borders of Belgium, and the other in Silesia. Only the former was represented at the Exposition; and although a full series of specimens from various localities were arranged in due order, there were only a few numbers which need to be mentioned. of Prussia;

136. The company of Stolberg Westphalen which extracts galena and zinc ores from deposits in dolimitic limestone, was remarkable for its ample collections and the importance of its products. Of lead, above 5,000 tons are annually produced.

134. The *Alliance* Company of Stolberg are combating greater difficulties in drainage than generally occur at the continental mines, and have erected a steam engine of 500 horse-power, on the Cornish principle, for pumping.

152. The *Eschweiler* company, also of Stolberg, are working under the direction of M. Eichholtz, on a very large scale, having 12 lead furnaces, 36 Silesian zinc furnaces, 20 for roasting zinc blende, 11 Pattinson pots, employing 1,500 work-people, and yielding products of the annual value of 120,000*l.*

140. *Suermondt and Co.*, working very fine crystalline galena, "potter's ore," from lodes in the Devonian rocks of *Wohlefat* in the Eifel.

Prussia produced in 1853,—

Lead	6,442 tons.
Litharge	763 "
Copper†	1,660 "
Silver	45,135 marks.

Belgium: Although the production of lead in this coun- of Belgium.

* It may be mentioned in illustration of the importance of these works that in the district of Lower Hungary (*Nieder-Ungarn*) upwards of 16,000 persons are employed at the mines. At Schemnitz alone 4,100 workmen are employed, and 150,000 tons of various ores are annually extracted, the greater part of the vein-staff having to pass under the stamps, of which no less than 1,756 heads are at work in the immediate vicinity.

† The copper works of Mansfield which yield about three fourths of the whole produce of Prussia, were unrepresented at the Exposition.

Mr. Smyth on Mining and Metallurgical Products.

try is not large, remarkable suites of ores and smelted products were contributed by the mines and furnaces of *Corphalie* (33), *Tellin* (29), and *Masbourg* (36).

In 1850 the quantity of lead produced in Belgium was stated at 1,178 tons, an amount which is now much exceeded.

Mines of the Hartz.

Hanover and Brunswick: The most complete mining collection in the Exhibition of 1855 represented the classical mines of the Hartz. A well-selected suite of specimens, illustrating the structure of the veins, was accompanied by a beautiful map and section, and an ingenious solid plan, contrived by the chief surveyor, Mr. Borchers. This latter, having the workings of each separate level laid down on a light framework, exhibited, by placing the different planes at proportionate distances above each other, all the phenomena of the lodes in the complicated workings of the mines *Dorothea* and *Carolina*, near Clausthal, and gave that complete view of the veins and excavations which cannot be obtained either by plans or sections. The dressing processes were rendered intelligible by an excellent diagram, and by models of all the machinery employed; and the smelting of the ores was similarly illustrated. A gold medal was awarded to the administration for this very instructive series.

Silver mines—

Silver.—This metal is so commonly associated with the ores of lead, that the mining operations by which it is extracted may be referred to what has been above said with respect to the lead mines, excepting in one or two remarkable instances.*

of Norway;

The mine of *Kongsberg*, in Norway, exhibited its well known specimens of native silver, and appears to produce this precious metal to the value of 47,000*l.* per annum.

of Mexico;

Mexico contributed a few examples of magnificent crystals of red silver ore; but it is well known that the produce of the Mexican mines is derived from large supplies of comparatively poor ores.

of Spain;

Among the continental exhibiting districts which furnish the largest amounts of the precious metals may be cited,—

Spain, yielding, according to the *Revista Minera*,

Silver	- -	173,890 marks, at 190 reals the mark.
Argentiferous ores		42,400 „
Gold	- -	65 „

* A remarkable statement accompanied specimens of argentiferous galena from Thea, probably to be explained by the fact of the compiler of the official Greek catalogue being no mineralogist, "ils contiennent 80 per cent. de plomb, *le reste* d'argent."

The Hartz, including Clausthal, Andreasberg, and Goslar, employing 5,450 workmen,— the Hartz;

Silver	48,500	marks.
Gold	10	„
Lead and litharge	98,000	cwts.

Austria yielded, in 1853, as follows,— of Austria.

Silver	120,547	marks.
Gold	6,292	„
Lead	93,368	cwts.
Litharge	21,671	„
Copper	45,265	„
Zinc	18,818	„
Quicksilver	3,378	„
Antimony (crude)	2,211	„

Zinc.—The United Kingdom, although not deficient in the ores of zinc, particularly in the sulphide or zinc blende, has not succeeded as yet in producing this metal on a large scale, and the demand is principally supplied from foreign countries. Zinc of Britain.

In 1854 there were imported,—

Of zinc or spelter	19,583	tons.
Of oxide of zinc	336	„

To the great company of the *Vieille Montagne*, which possesses almost a monopoly of the trade, and carries on works in Belgium, Prussia, and France, we are indebted not only for an enormous production and the reduction of the price of this useful metal, but also for its application to a great variety of purposes. As in 1851, so in 1855 they were remarkable for a full and complete illustration of the ores raised from various localities, and of the multifarious products derived from them. Vieille Montagne Company.

This company, now making enormous profits, employs the ore called blende as well as calamine. For many years this substance, so rich in zinc, had been almost valueless, from the difficulty experienced in getting rid of its sulphur; but the application of the reverberatory furnace to the preparatory calcination appears in great part to have overcome this obstacle.

The Vieille Montagne Company, besides working the mines for zinc, lead, and some copper and iron ores, as well as their own collieries, purchase largely from other works the raw material for further manufacture. It is stated that they produce of sheet zinc alone 25,000 tons, and of zinc-white for paint 5,000 tons annually, employing directly about 7,000 workpeople.

Mr. Smyth on Mining and Metallurgical Products.

Whatever may be advanced in the abstract against the virtual monopoly exercised by so powerful an association, it must be conceded that it commands respect not only by the magnitude of its operations, but by the intelligence and skill which it has brought to bear upon the various processes, and by the liberal and considerate spirit in which, whilst not unmindful of its own profits, it consults the comfort and well-being of its workmen.

Nouvelle Montagne Company.

Among the establishments which endeavour to emulate the above, I may instance more particularly the *Nouvelle Montagne* (Belgium, 34), which yields annual products to the value of nearly 80,000*l*. They exhibited a very complete series of specimens, including ingots, wire, and sheets of the metal cadmium, which, however curious in itself, and applicable to the manufacture of certain pigments, is, from its association with the zinc ores, somewhat detrimental to their value.

In Prussia the *Eschweiler* Company (152), and that of *Westphalia and the Mark* (138), also exhibited samples of zinc, produced on a large and profitable scale.

Rarer metals, Cobalt and Nickel.

The mining and metallurgical treatment of the metals of rarer occurrence was but partially represented. The ores of cobalt and nickel, and some of their furnace products, were contributed by a few exhibitors in France, Prussia, Austria, and Nassau. One of the most remarkable exhibitions was that of *A. Schœller*, at *Berndorf* (Austria, 90), including, besides the more ordinary specimens, a sheet of nickel-silver (an alloy of copper and nickel), above forty feet long and thirty inches wide.

Uranium.

Among these rarer metals may also be mentioned the fine examples of Uranium ore (pitch-blende), derived from the mines of *Joachimsthal*, in the north of Bohemia (Austria, 95). These mines have within the last five years been brought into a state of greater activity, and now produce annually, besides some 6,000 marks of silver, 100 cwts. of uranium ore. It is principally for imparting a beautiful canary-yellow colour to glass that the "Uranium-yellow" is used; the increased production of Joachimsthal has been the chief means of reducing the price from sixty to twenty-four shillings per pound.*

Manganese.

Manganese and antimony ores were exhibited by several countries, the former especially by Nassau, which produced

* The ores are roasted with lime, and then dissolved in sulphuric acid. Carbonate of soda is then added, and the resulting Glauber's salt eliminated by washing.

in 1852 about 9,000 tons of the ores termed psilomelane and pyrolusite, so important for glassmaking and bleaching purposes. About 2,000 persons are employed in the district of Runkel, Limburg, Hadamar, and Weilburg in the extraction and preparation of these ores.* Mr. Smyth on Mining and Metallurgical Products.

Section Ninth.

Non-Metallic Mineral Products.

In this section, the number of British exhibitors was so small,—only 13, against 65 from France, 27 from Austria, 10 from Belgium, and 9 from Prussia, and their contributions were so accidental, that I may be permitted to bring forward only a few of the objects in the Exposition at large which merited attention.

Graphite or plumbago, which once made our lake district of Cumberland famous throughout the world, was not exhibited by England, but is now produced in vast quantities in several of the Austrian provinces. Baron Kaiserstein exhibited it from Raabs in Lower Austria, where he raises 6,000 cwts. per annum; and Prince Schwarzenberg sent fine specimens from his mines at Schwarzbach in Bohemia, where no less than 60,000 cwts. are produced yearly. Within the last few years, new sources of this substance have been opened to us in Ceylon, in Canada, and Greenland, but it remains to be seen how far quality and price will render them available on the large scale. Graphite largely produced in Austria.

Millstones formed an important item in several of the collections. None can equal for grist mills, the celebrated "Burr-stones" of La Ferté-sous-Jouarre (Seine et Maine), expensive though they are in consequence of the necessity of carefully piecing them together. The combined roughness and hardness of this tertiary quartz deposit give it the advantage over several competitors excellent for other purposes. Mr. Landau, of Andernach on the Rhine (Prussia, 161), exhibited admirable millstones, which are sold at a comparatively low price, made to the largest size in single blocks from the rough gray trachite of that district. Belgium (40, 45, 47) contributed examples of the application of a new "Silex molaire," in the *chert* of the mountain limestone, which near Charleroi and Namur forms, as it does in parts of North Wales, massive beds of considerable thickness. Millstones—of France; Andernach; and Belgium.

* An excellent *aperçu* on the minerals of Nassau, in an industrial and geological point of view, was prepared for the Exposition in Paris, by Dr. Guido Sandberger, under the auspices of the Ducal Government.

Mr. Smyth on Mining and Metallurgical Products.

Building stone.

The rocks employed as building and ornamental stone were in some instances placed in the 1st, in others in the 14th and 24th Classes. A good collection of the Cornish building stones was contributed by the Royal Commissioners of the Exhibition of 1851; and the Cheesewring Granite Company gave an example in a fine pedestal, of the white Cornish granite, which from the large size and moderate cost at which it can be obtained, is particularly suitable to constructions on a large scale. A great number of granites and marbles were afforded by France, and Corsica was particularly remarkable for its cipollino and other marbles. The "agate marble" of Ain Tekbalek in the province of Oran, of which slabs and some vases, purchased by the Duke of Wellington, had been prepared, was among the most attractive objects in the Exhibition, and was particularly interesting as being derived from the re-discovered quarries, in which the Romans used to work the material so similar to the admired arragonite (miscalled oriental alabaster) of Egypt.

Roofing slate.

The French slate quarries of Rimogne, Beville, and Angers contributed full collections of their products, which although so serviceable as to be largely employed, and to occupy some thousands of workmen, were scarcely equal to those sent by Messrs. Greaves and Holland from Ffestiniog in North Wales.

Marbles of Austria,

A few of the ornamental stones exhibited as material, without reference to artistic treatment, may be mentioned.

Austria exhibited good variously-coloured marbles from Adnet, St. Johanns, Untersberg, and Wiessthal, a very beautiful series from Bergamo, and handsome dark serpentine from Lend and Gastein.

and Greece.

Among the more interesting were the following specimens from Greece:—

Rosso antico slabs 40 inches by 12 inches, interstratified with white marble, from Laconia.

Bréche de Médée, gray fragments in a reddish ground, from Argolis.

Bréche de Sparte, gray, with curious white markings, apparantly from corals.

Green veined *cipollino*, from the quarries of Carysto, in Negropont.

Marbre de Mantinée, in reality a *porfido verde antico*, with the felspar crystals of a pale olive tint, but tending to decompose in the centre.

Marbre de Ténos, a fine green serpentine, with white veins.

Turkey exhibited slabs of a very beautiful translucent arragonite, found near Tocat, which a century or more since was largely employed in ornamental work, although now seldom seen in articles larger than dagger hilts or the mouthpieces of tchibooks.

In the Indian collection were small slabs of a greenish yellow marble, from Bellary, Madras, which should be valuable if it can be obtained of larger size.

Spain and Portugal contributed a great variety of marbles, many of them very fine in colour.

Materials of porcelain.

It is notorious that great admiration was lavished in Paris on the earthenware and china of the English manufacturers, and that the low prices at which they could be obtained were a cause of surprise to the French public, accustomed to the expensive though beautiful Sêvres. It may be interesting therefore, in conclusion, to refer to the materials of pottery in the two countries as one of the chief elements in the difference of price.

Mr. Pike, of Wareham, the chief exporter of the Dorsetshire clay, exhibited a collection of that substance, which is shipped from Poole at the rate of about 70,000 tons a year; and a series of the varieties of China clay (Kaolin) of Cornwall represented that important branch of enterprize which exports annually about 80,000 tons, principally to Staffordshire.

Kaolin, of Cornwall,

The Cornish china-clay has all to be obtained from the granite with decomposed felspar by a series of washing and decanting processes, which have for their object the elimination of quartz, mica, and other admixtures. Still, even after this preparation, it is scarcely equal in whiteness and beauty of appearance to the Kaolin which was exhibited from St. Yrieix, near Limoges, but it has so great an advantage in price that it has even been imported into France. The best qualities from Cornwall cost at the works in Staffordshire 50*s.* or 52*s.* per ton; the so-called Cornish stone, after the grinding which it requires, 70*s.* The French Kaolin, which is, in fact, decomposed granite, costs at the works when ground, 4*l.* or 5*l.* the ton.

and France,

applicable to different kinds of porcelain.

I am informed by my friend M. Arnoux, of Messrs. Minton's works, that this latter Kaolin is far superior to any used in Germany, but not being applicable to the manufacture of earthenware or soft china (*pâte tendre*), unless freed from its imbedded quartz, it has stimulated the produc-

Mr. Smyth on Mining and Metallurgical Products.

tion of the hard china (*pâte dure*), in which France is pre-eminent. That obtained from Cornwall, on the other hand, would not form a hard porcelain so fine and translucent as the French, but having its particles in a minute state of subdivision, is excellently adapted for the earthenware and soft china or porcelain, which our manufacturers have brought to a high state of perfection. A curious and not generally understood instance is thus afforded of the dependence of the special variety of manufacture in different countries on the mode of occurrence of its raw materials. It may be added that examples were furnished by Baron de Veauce (France, 5,274), of Kaolin from a newly-discovered locality in the Department de la Niévre, which is said to promise larger quantities than the Haute Vienne.

Limits of deliberations of jury.

In conclusion, I must remark that our international Jury was greatly indebted for its smoothness of action to the kindness and liberal feeling of Elie de Beaumont, the President, and M. Devaux, the Vice-President, as well as to the unremitting exertion and widely-extended knowledge of M. Callon, of the Ecole des Mines, who acted as Secretary. The only serious difficulty in forming conclusions lay in the questions, 1st, how far, in subjects requiring a great variety of scientific study and technical skill, it was desirable to regard excellence other than that which appeared in the products exhibited; and 2nd, in what degree the magnitude and importance of establishments should entitle them to be distinguished.

Minerals, metals, and the processes by which they are discovered, worked, and brought to a certain stage of elaboration, formed the substance of the investigations of the Jury of the 1st Class. It was reserved for other Juries to consider these objects with reference to their farther application; and thus the suitableness of certain irons to particular purposes, the adaptation of alloys to various manufactures, &c., remained to be reported on by persons practically conversant with the special branches of industry.

Lesson taught by the Exhibition.

However partially, in some respects, she may have been represented, Great Britain should, perhaps in a greater degree than other nations, learn a lesson from the Exhibition of 1855. Articles once manufactured exclusively by us are now produced in large quantities by several other nations; their natural stores, which had long been neglected, are fast developing under the influence of associated capital; and every step in advance is firmly planted, because it results more from the establishment of definite scientific

principles than from hap-hazard trials, or mere manipulative skill. On most points we are still far ahead, but let us take timely heed, lest deficiency of system and of well-grounded knowledge should, in spite of our natural advantages, expose us to a much nearer race with the inventive genius and adaptability of the French, and the firmly-based perseverance of the German nations.

I have the honour to be, &c.

WARINGTON W. SMYTH.

London, 1st March 1856.

Class VI.

To the Right Hon. the Lord Stanley of Alderley
President of the Board of Trade, &c. &c.

President of the International Jury on Class VI. It is already been rendered apparent by actual results.

visible in the Paris Exhibition, in the richer and more varied collections of raw products; in machinery of ingence, and in a varied display of tasteful designs.

but with it I can see no reason why we should not maintain

distinguished as a nation.

portions:—

1. The minerals of different countries, including the

On Machinery in General.—By William Fairbairn, C.E., F.R.S., and President of Jury for Class VI.

Mr. Fairbairn on Machinery in general.

To the Right Hon. the Lord Stanley of Alderley, President of the Board of Trade, &c. &c.

My Lord,

My intention in the following Report is to give a concise account of the objects in the Paris Exhibition of 1855 which came more immediately under my notice as President of the International Jury on Class VI. It is scarcely necessary to enlarge on the immense benefits which these periodical competitions are likely to effect, inasmuch as their influence on the industrial progress of the world has already been rendered apparent by actual results.

Object of the Report.

In my inquiries into the novelty and value of the articles exhibited at Paris, I shall necessarily have occasion to draw a comparison with those exhibited in London four years earlier, and I think it will be found that, especially in those branches of the industrial arts with which my own investigations have been connected, foreigners have been no inattentive readers of the great book of knowledge which we opened for their instruction. They appear to have come to London, not merely to gaze and admire, but to learn and improve; and the fruits of their study and observation were visible in the Paris Exhibition, in the richer and more varied collections of raw products; in machinery of improved design and better construction; in manufacture generally creditable, and in some instances of rare excellence, and in a varied display of tasteful designs.

London and Paris Exhibitions compared.

It will be well if Englishmen prove that they in their turn have profited by the examples set before them last year, and that they are fully alive to the necessity of the constant application of scientific knowledge in their industrial pursuits. Without due attention to this vital point, our position as a manufacturing people will be jeopardized; but with it I can see no reason why we should not maintain superiority in those branches of industry, which have hitherto distinguished us as a nation.

Benefits which we may derive from the Paris Exhibition.

The subject of my Report may be divided into two main portions:—

Division of the subject.

1. The minerals of different countries, including the various useful ores, and other raw products, with

Mr. Fairbairn on Machinery in General.

their geographical positions, comparative abundance and richness.

2. The mechanical agencies by which these products are converted into articles of utility, comprehending the mechanism employed in manufactures generally.

Raw Materials.

Raw Materials from Canada, Algeria, Australia, the United States of America, and Great Britain.

The collections of raw products from Canada, Algeria, Australia, and the United States of America were remarkably complete and interesting. The mineral wealth of Great Britain was, unfortunately, not so well represented, the collection being inferior, both in extent and variety, to that exhibited in 1851. Great credit is due to Mr. Logan for the beautiful classification of the Canadian collection, which was of immense value to the geologist and mineralogist.

The arrangement of the contributions from other States was not so perfect, but many of the individual specimens were of great interest, and indicated the existence of mineral treasures which will, at some future period, yield almost inexhaustible riches to the countries producing them.

Mineral resources of Ireland.

The inferiority of the contributions from Great Britain was much to be regretted, as there is no country in the world more highly favoured in its mineral resources, and in no other country has greater intelligence or greater activity been employed in perfecting the processes by which the ores are rendered available for use. In the preparation of iron especially Great Britain stands pre-eminent; of this invaluable material we are the largest producers and the largest exporters in the world. The present production of pig and crude iron in this country is estimated at not less than 3,000,000 tons per annum.*

* Since the above was written, Mr. Kenyon Blackwell, in a valuable paper read before the Society of Arts, gave the following estimate of the production of pig and crude iron in different countries, from which it appears that Great Britain produces one-half the total quantity.

	Tons.
Great Britain	3,000,000
France	750,000
United States	750,000
Prussia	300,000
Austria	250,000
Belgium	200,000
Russia	200,000
Sweden	150,000
Various German States	100,000
Other countries	300,000
Total	6,000,000

MR. FAIRBAIRN ON MACHINERY IN GENERAL.

In this Report it will not be necessary to enlarge on the varied mineral products of different countries; but as iron enters largely into the constructive and industrial arts, I shall confine my observations to that metal, and endeavour to show not only the extent of our resources, but the state of our manufactures, as compared with that of other countries. This inquiry seems to be called for, inasmuch as the Exhibition just closed afforded evidence of rapid progress in the manufacture of this material, and the splendid specimens submitted by various Continental States presented unmistakeable proofs of a rising activity in every department of metallurgic industry.

Mineral resources of Great Britain, compared with those of other countries.

I shall therefore endeavour to take a review the mineral resources of this country as compared with those of America and the Continental nations of Europe, the comparative natural facilities of this country for working and reducing the ores, and the different systems adopted in the processes of their manufacture.

The Iron Ores of Great Britain.

Nature has been lavish in the distribution of her mineral treasures in this country. The iron ores are almost inexhaustible in extent, and, what greatly adds to their value, they are generally found to alternate in position with the large coal strata, and occasionally the flux necessary for their reduction is in close proximity. These advantages are almost peculiar to this country, and although iron is found in every formation and in every region, it is only in Great Britain and some few other localities, that the iron ores are so closely imbedded with cheap mineral fuel; and yet all these conditions are essential to the development of a large and profitable production. In Norway and Sweden, for example, the magnetic ores are exhaustless; but in those countries coal is wanting, and hence the difficulty and great expense of the manufacture. In Great Britain there are at least four or five great producing districts, where the ore and the fuel are found in juxta-position. Nearly the whole of these ores, particulary the earthy carbonates of black bands, are found in almost inexhaustible abundance, interstratified with the numerous coal-fields of Lanarkshire, Ayrshire, and some of the districts of South Wales. And it is only in some of the coal-fields of the northern counties that these ores are not found in sufficient quantity and purity to render them eligible for reduction. In north Lancashire and in Cumberland the red ores exist in great variety and abundance, and they are considered of great value when used as an alloy, for mixing with the poorer description of the clay iron-stones.

The iron ores associated with coal, &c. Peculiar advantages of Great Britain.

Mr. Fairbairn on Machinery in General.

In fact, such is the richness of these ores, that large quantities are annually transported from Ulverstone and Whitehaven into South Wales, Staffordshire, and Scotland, for the exclusive purpose of improving the quality of iron manufactured in those districts. Altogether Great Britain possesses remarkable advantages over other countries in the peculiarities of her mineral treasures, and taking into consideration the extent of her coal-fields, and the power which these extensive mines afford for the smelting and manufacture of lead, copper, and iron, it would be a disgrace to us if we did not stand pre-eminent in this branch of industry.*

Mineral resources of Ireland.

Sir Robert Kane, in his Industrial Resources of Ireland, gives an account of the vast mineral deposits which exist in that country, and also of the abundance of iron ore which is to be found in various districts and localities. These ores have not, however, been worked to any great extent, owing mainly to the absence of coal.

The time may, however, arrive when they will be turned to profitable account, and the hope in this respect is rendered the more probable, by the establishment of railway communication with the large tracts of peat moss, which, if properly prepared and carbonized, would produce fuel of great value for smelting purposes.

Very many of the Irish ores are of a superior description, and provided they were smelted with carbonized peat, it is more than probable that iron would be produced equal in quality to the best Swedish metal or to the charcoal iron of Newland, in North Lancashire. This iron, if properly prepared, might be worked at a cost calculated to meet the market for our finest description of iron and steel, or that quality from which our finest wire is produced.†

The Iron Ores of France.

Distribution of the iron ores.

The iron ores of France are various in form and character: those of the Jura are found stratified in beds, and in some cases widely dispersed, or accumulated in masses in the

* The specimens of iron ores and coal exhibited in the Annexe, as also those of steel, are equal, and in some cases superior, to those exhibited in Hyde Park in 1851. On that occasion there were the following varieties:—

Hæmatite iron ore, Ulverstone, yielding	-	-	66·47 metal.
Kidney ore from Balcarry Bay „	-	-	70·00 „
Clay iron-stone, Arigua Mines, Ireland, yielding	-		60·00 „

If we add to these the argillaceous, calcareous, and siliceous hæmatite iron ores, the magnetic oxides, anhydrous hæmatites, the poorer ores of Staffordshire, and the black band of Scotland, we enumerate nearly the whole of the varieties exhibited at the Great Exhibition of 1851. And so far as can be judged from personal inspection, the collections in the Annexe were nearly similar in variety nd quantity.

† See Tables in Appendix III.

form of small kidney-shaped concretions, imbedded in the fissures of the limestone by which they are surrounded. Many of these deposits are only slightly covered by sand and clay, and in some cases are found scattered over the surface. They are found dispersed over many parts of France. They are present in the Department of the Yonne, the Meuse, the Moselle; in fact, they may be traced from the Pas de Calais on the north, to the Soane and the Jura on the south, indicating throughout an abundant and ample supply. The difficulty, however, that exists is the want of coal in the immediate neighbourhood of the ores. Although the mining and washing of the ores is cheap, the carriage is expensive, and adds greatly to the cost at which the iron can be produced.

The want of coal in the immediate neighbourhood.

The smelting of iron ores in France is, however, greatly on the increase. The facilities afforded by railways for the transit of the mineral products of the country have given of late years a wonderful stimulus to this branch of industry. Ten years ago nearly all the French iron was smelted by charcoal, but since the introduction of railway communication permitting the use of coal, the manufacture has advanced with a rapidity which has already doubled, and may very shortly quadruple the production.* Notwithstanding this progress, the French continue to import large quantities of iron.

Influence of railways on the manufacture of iron.

The French are perfectly aware of the importance of the application of iron to purposes of building, and almost every house of any value now erected in Paris or any other large town of France is constructed with iron joists, and made fireproof. An equally great demand exists for railway constructions and bridges of great span, iron ship-building, and similar works of equal importance, where iron is the chief material employed.

Iron used in construction.

The Iron Ores of America.

In the United States of America, we have the same indications of an extended and increasing demand for manufactured iron as in France. The productive powers of the native ores are about the same in both countries; but looking at the number of square miles over which the former great country extends, we arrive at the conclusion that at no very distant period its iron industry must become of great importance.

Ores of the United States of America.

* Canal navigation, although greatly extended and encouraged by Napoleon I., was not calculated to meet all the requirements of an active progression. It only extended (with the exception of the great links of communication) to a few localities, and these were at some distance from the markets or the seat of consumption.

Mr. Fairbairn on Machinery in general.

We find the ores widely diffused, and the immense fields of anthracite and bituminous fuel are sufficient guarantees for the extension of the manufacture; and those supplies, which at a future period may be brought into use, will add to the industrial resources of the country. At the present time the quantity of iron produced from the ores in America is about the same as in France, or one-fourth that which is produced in Great Britain. Certainly the Americans import large quantities of British iron, on account of their inability to supply the ever increasing demand for railways and other works.

The distribution of the ores.

The iron ores of America are various in kind and degree. The carboniferous, hæmatite and magnetic ores are found in different localities; but the valley of the Mississippi, west of the Alleghany mountains, is not only the great coal region of the States of Western Pennsylvania, Virginia and Ohio, but also the great iron ore district of that immense country, from which future generations will probably derive their supply. As yet very little is known of this enormous tract of carboniferous deposits.

Want of cheap transit.

There is the same want of communication between the ores and the fuel as in France. This want applies even to the valley of the Mississippi, where the products of the ores have to be transported, either by land or water, from the furnace to the market; but the ready resources of the Anglo-Saxon race will surmount these difficulties, and railways and canals will no doubt be constructed in rapid succession to meet the demands of the times.

Smelting works of America.

The districts in which the smelting and manufacture of iron is carried on, east of the Alleghany range, are those of New England, New York, Pennsylvania, and Maryland; on the western side of the Alleghanies, Western Pennsylvania, Virginia, and other districts. Most of the ores are smelted with charcoal, and some with anthracite coal, which is found in the eastern parts of New England, New York, and the eastern shores of Pennsylvania. The whole of the eastern States appear to be well situated for the manufacture of iron, but the greater part of this manufacture must eventually establish itself in the valley of the Mississippi, where both ores and fuel are found in abundance.

The Iron Ores of Prussia, Austria, &c.

Ores of Prussia.

The production of iron in Prussia has been greatly augmented of late years, and there cannot exist a doubt that the same cause which has induced so large an increase in other countries has had its influence on Prussia also. The railway system in that country, as in all others, is largely developed,

and the demand for manufactured iron bears a relative proportion to the extension and increase of this new system of communication. The consumption is not so great in Prussia as in France, and, with the exception of railways, roofs, and rolling stock, iron as a material for building is not so extensively used. It is applied to some extent in buildings, and the architects of Berlin and other parts of Prussia have availed themselves of it in the construction of the floors and domes of their great works, such as palaces, churches, &c. It is also used in the construction of bridges, chiefly of the lattice form, but in other works, excepting only those of agriculture and machinery, it is not much in demand.

Iron manufactories of Prussia.

The chief seats of the iron manufacture are in the vicinity of the great coal-fields of Ruhr, where are found valuable strata of the black band, carbonate ore, and clay carbonates, similar to those found in Scotland and other parts of the United Kingdom. This mineral district is intersected by railways, and the River Ruhr, which communicates with the Rhine, affords great facilities for transit. Besides these black band and clay carbonates, there exist in Rhenish Prussia several varieties of hæmatite ore, of what quality I am unable to determine; but they are found valuable for mixing with those of Westphalia, and, I believe, may be worked at a moderate cost.

On the eastern side of the Kingdom, in Upper Silesia, on the Vistula and the Oder, large deposits of coal and iron are found, and several furnaces are now in operation for smelting and other purposes, in connexion with iron in its more advanced stage of manufacture.

Ores of Austria.

Austria does not manufacture iron to the same extent as Prussia, but her iron is of excellent quality. This arises from the ores being smelted and worked with charcoal, or in some cases with carbonized peat. It is similar to the Swedish metal, and like all other iron of this kind, is applicable to every description of manufacture, from the most ductile wire to the hardest steel.

The ores are found in Hungary, Styria, Moravia, and Upper Silesia, and in each of these localities they are worked with charcoal and peat.

Ores of Belgium.

Belgium is another country where both coal and iron of good quality are found in equal abundance. The coal measures extend across the country from east to west, and on them are the extensive works of Cockerill and Co., at Seraing, near Liege; there are works of a similar character at Charleroi and other places in the immediate vicinity of the coal measures. The ores, which are chiefly hæmatite, are derived from the carboniferous limestone which lies at the base of the coal.

Mr. Fairbairn on Machinery in General.

Ores of Sweden.

The quantity of iron produced in Sweden is not considerable, but that produced is of the very first quality, owing not only to the very fine quality of the ore, which covers the face of the country to an immeasureable extent, but also to its being smelted with charcoal, and worked in all its subsequent processes by the same material. Coal does not exist in this country, and even in the iron districts the makers are limited by law to a certain number of trees per annum on account of the forests, which the proprietors of the towns are bound to maintain. These laws are a great drawback to the Swedish iron-masters, and most seriously operate against the extension of this most important branch of manufacture.

Ores of Russia.

In Russia the state of the iron market is not so well known; but several extensive works are in operation in the Ural mountains; and the great works of Tulo, and some others in the interior of that vast country, evidence a progression, that must, nevertheless, be limited in extent from the want of mineral fuel.*

Iron in its Manufactured State.

Specimens of pig, bar, and plate iron.

If we proceed from the consideration of the raw material to that of its manufactured products, several splendid specimens present themselves in the Annexe of the Paris Universal Exhibition; and in this department were exhibited samples of pig, bar and plate iron certainly not inferior to anything yet produced in this country.

The French superior in large forgings.

In forging large masses of malleable iron, the French works are decidedly in advance; and we have only to refer to the forged stern post and framework for the rudder and screw propeller of a large ship manufactured by Messrs. Schneider & Co., of Creuzot, and to other works by Jackson et Frères, to be convinced of the superior character of that description of difficult manufacture. Certainly the Mersey Iron Works at Liverpool, Rushton and Eckersley of Bolton, and Messrs. Nielson and others, of Glasgow, have produced superior forgings of immense weight; but I question whether any work of that form and size was ever produced either in this or any other country.

Use of the steam hammer.

In the use of the steam hammer and steam tilt hammer, the French appear to be as far advanced as ourselves, and most of their forgings, such as wheels, axles, &c., are exceedingly well manufactured, and in the larger description of articles, such as the stern posts for iron ships mentioned above, and in large shafts for engines of great power, the French

* For a full description of the geological formations and of the deposits of iron ore, *see* Mr. Blackwell's interesting paper.

works are certainly not behind the best conducted works of this country.

MR. FAIRBAIRN ON MACHINERY IN GENERAL.

We pass from the manufacture of cast-iron, forgings, &c. to the conversion of iron into steel; and here we have apparently much to learn, if we may judge from the specimens exhibited by Messrs. Krupp, sent from their manufactory at Essen, near Dusseldorff, in Prussia. There was nothing from Sheffield or any other part of this country to compare with them. In the article of cast steel from under the hammer and tilt, there were some of the finest specimens ever exhibited; some of the pieces are upwards of four tons in weight; and whether we examine the larger or the smaller specimens, the same appearance of homogeneous density in granular structure is strikingly apparent. I have not been able to learn the strength, elasticity and power of resistance to strain of this material as compared with others, but judging from the beauty of its crystalline structure, its tenacity, and high specific gravity, I should consider it one of the finest, and probably one of the most useful descriptions of this kind of manufacture that has ever been produced.*

Manufacture of steel.

It would be invidious to say that we cannot make steel of equal quality with that of Krupp. There may not be the demand for it. But certainly we have never yet presented for public inspection such splendid specimens as those brought forward by Messrs. Krupp during the London Exhibition of 1851, and more recently in that of Paris.

Prussian steel superior to British.

After the notice given of Messrs. Krupps' manufacture, it would appear invidious if I did not furnish a short description of a new process invented by M. Chenot.

M. Chenot's process for making steel.

M. Chenot's works, or rather those of Messrs. Bugeney and Co., are in the immediate neighbourhood of Paris, and having visited them on two different occasions, I have less hesitation in giving a brief statement of this peculiar process, so far as I could gather it from M. Chenot, and his son, who have the management of the works.

* Since the above was written, I have had an opportunity of witnessing one of the severest tests to which material of this kind can be subjected, namely, in the shape of ordnance. Messrs. Krupp constructed a large 68-pounder gun of their cast steel, and sent it over to this country, where it was cased in cast iron. The cast steel gun weighed between three and four tons, with the iron casing nine tons. It was tried at Woolwich; the proof charge was 25lbs. of powder, one wad, and one of the projectiles, weighing 2cwt. 1qr. 7lbs., which was made by the inventors for use with the gun. The quantity of powder was less by 3lbs. than that usually employed in the trial of 68 pounders. At the first discharge the gun burst, scattering the fragments high into the air, large pieces flying in various directions; the muzzle portion went forward with the shot several yards; the shot took the proper direction, and was imbedded in the sand butt. The sensation at the result was very great, as some supposed it capable of resisting any amount of powder. Its declared value was 1,000*l.* to 1,500*l.*

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M. Chenot makes steel direct from the ore by converting it first into a substance he calls *sponge*, in a peculiarly constructed furnace, 50 feet high and about 18 feet square at the widest part. To this furnace are attached other furnaces, which contain the fires, and great care is taken that the fuel should not come in contact with the ores. The large furnace is constructed with numerous intersecting flues to distribute the heated currents from the attached furnaces, and to equalize the temperature at those parts where they come in contact with the ores.

It requires five days to convert the ore into sponge, and every twenty-four hours 18 cwt. or one ton are drawn from the furnace, at a temperature of 180° Centigrade. The sponge is drawn from the furnace by a moveable grated platform, which rises by rack and pinions to the requisite height in the furnace, where it receives the charge, and is lowered at the required temperature to the space prepared for its reception below. Great care is taken to shut out the atmosphere by a luting of sand and clay all round the platform on which the sponge is removed from the furnace.

The ore being thus calcined, or converted into sponge, it is allowed to soak in oil or any other fatty substance calculated to supply it with carbon. After this it is placed in wrought-iron retorts, and exposed for a couple of hours to the heat of a furnace, in order to carry off any excess of carbon which it may have received. The sponge is next reduced to powder, and then by machinery compressed into bars in strong iron tubes. In this state it is fit for smelting, and being placed in the crucible, with four tons of coke to one of sponge, it is thence run into ingots. Lastly it is prepared for the market in the usual way under the hammer. On the quality of this manufacture I can speak with some certainty, as I brought several specimens home with me; and, judging from these, I can safely pronounce the Chenot manufacture a superior description of steel. I am not acquainted with the commercial value of the article, but I understand that cast steel can be produced by this process at little more than 30*l.* a ton.

Articles from Sheffield.

From Sheffield some very fine specimens of cast and blister steel were exhibited, and also some fine specimens of manufacture from cast steel; but it must be admitted that so far as the material is concerned, there was nothing shown, either from this country or from France that would bear comparison with that manufactured by Krupp. I had no opportunity of ascertaining by what process these interesting specimens of manufacture are produced. I am informed that it is retained as a strict secret.

British pig, bar, and plate iron smelted by the hot blast.

In the manufacture of pig, bar and plate iron, Great Britain has hitherto, and will probably continue to take a first rank, as regards both quantity and cheapness. It is not, however, first in every sense; as regards quality it is inferior: and although the quantity of iron produced annually is upwards of 3,000,000 tons, it is of a quality that cannot always be depended upon for cohesive strength and resistance to strain. This does not arise so much from any defects observable in the ores or the fuel, but chiefly from the rapidity with which it is produced by the application of the hot blast and pit-coal in the process of smelting. Formerly, before the application of this process, the blast furnaces of this country yielded from 40 to 60 tons of good iron per week, and that with an expenditure of 6 to 7 tons of coal in the shape of coke for every ton of iron. Now from three to four times the quantity is produced by the hot blast with little more than one-third the quantity of fuel; and that again from the raw coal and raw ore, without the expense or trouble of the coking and roasting processes.

Increased production by means of the hot blast.

The result of this immense saving, and the increased production, is a loss of strength, arising probably from the rapidity of the process and the consequent contamination by sulphur and phosphorus, two substances highly detrimental to the cohesive force with which the crystals of iron unite.

Let me not be supposed to express a doubt that this cheap process of reducing the ores is as a whole, a great benefit to the country, as hot-blast iron, generally speaking, is of great value for many purposes where strength is not an important element of its utility. Its fluidity, and the ease with which it can be worked, render it applicable to every description of construction that is not subject to severe strain.

Advantages of the hot blast.

In the construction of artillery, beams, and bridges, it is not, however, at all times to be depended upon, and it would be well in every structure of this kind to use it sparingly, or only as an alloy for reducing some of the harder and stronger iron.*

Defects of the hot blast.

* It is rather extraordinary, and not uninteresting, to watch the variable character of the hot-blast iron from the same works at different times, when smelted probably under different conditions and temperature. I have observed, at one period, specimens of iron to be elastic and strong, while others sent from the same works at another time have been weak and comparatively soft and short in their granulated texture, when submitted to strain.

I may further mention, that shortly after the employment of the hot blast, a total change came over the pig iron market, by the introduction of a description of iron smelted from the cinder heaps of Staffordshire and other places. This iron gave the hot blast a rather unfavourable character. Such were the facilities which this new process had introduced, that the cinder heap iron, when re-melted, not only broke short off, but shrunk or lost in cooling one-ninth or one-tenth its original bulk.

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Whilst offering these observations, I should wish it to be understood that I do not condemn the hot-blast manufacture. On the contrary, I think it should be still more extensively pursued, as I have not only found that some of the best iron is derived from this source, but in some instances, in its powers of resistance to transverse strain and to impact, it has proved equal to some of our best cold-blast iron. The only objection to it is a want of uniformity of character, which renders its application at times uncertain.

Improvement of the quality of hot-blast iron.

If greater care were observed in its manufacture, and a more judicious selection of the ores and fuel made, I can see no reason why a perfectly strong and rigid description of iron should not be made. Besides, I am of opinion that two kinds, possessing all the properties of strength and elasticity on the one hand, and high working qualities, such as ductility and fluidity, on the other, may be produced; and in effecting these objects it would enable the architect and engineer to make a selection with a certainty that they were purchasing an article suited to the purpose for which they intended it. If these two distinct qualities could be obtained, we should not, under the present exigencies of a war, have to experiment and hunt up material from every quarter of the globe to strengthen and render more durable our guns and mortars. Let us hope that more attention will be paid to this important branch of industry, and that we shall shortly be enabled to look upon the manufactured iron of Great Britain as the result of careful attention to all the requirements of quality as well as quantity.

Malleable Iron.

Rolling of bar and plate iron.

To the rolling of bar and plate iron the French and every other nation in Europe have been paying the utmost attention. I have already noticed the immense works of Schneider and Co., of Creuzot, and those of Jackson et Frères: to these may be added those of Cockerill, at Seraing, near Liege, Gandit et C^ie^, Forge et Fonderie de Montataire, and some of the larger works of Prussia, which at the present moment are in full activity. I have not had the means of ascertaining the amount of the production of these works; but I have seen and examined numerous samples of the work produced, and it is but fair to state that the quality of the rails, bars, and plates, whether viewed in regard to dimensions, weight, or workmanship, is not inferior to that of any manufactured in this country. In the manufacture of the thinner and finer descriptions of plates they excel, and some of these rolled for tin are so thin and so remarkably sound as to be designated by the name of iron paper. All these

Excellence of the Prussian thin plates.

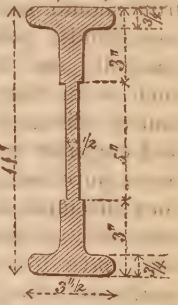
plates are of excellent quality, and exhibit in a high degree the important qualities of flexibility and strength. The specimens of rolled bars and rails in this exhibition were not superior to our own, but several excellent specimens of railway wheel-tyres of large dimensions were exhibited.

The French superior in the manufacture of wrought iron joists.

In the manufacture of wrought-iron beams and joists the French have taken an undoubted lead; and the specimens exhibited from the Forge et Fonderie de Montataire, and others indicate a degree of perfection which has not as yet been attained in this country. Some of the joists, of the sectional dimensions shown in the annexed sketch (Fig. 1), were rolled 60 feet long; and another specimen of still greater dimensions as at Fig. 2, was rolled 40 feet long. These specimens, and several others of different sizes, show how much has been done, and how much may yet be accomplished in this branch of manufacture; and we have yet to learn why the same facilities cannot be afforded for the introduction of this class of work direct from rolls by the iron-makers of England and Scotland. If this description of beams were properly rolled and manufactured, it would effect a great saving in mechanical construction, and would, at the same time, produce much greater certainty in the strength of beams, by dispensing with the present system of joints, and the riveted angle iron, which constitute at the present moment our defective mode of constructions, as shown in the section Fig. 3. It would introduce also into our present system of manufacture a new and greatly enlarged branch of industry, adapted to all the requirements of the architect, the builder, and the engineer.

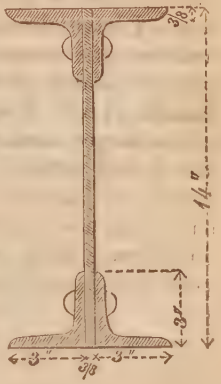
Fig. 1.

Fig. 2.



Value of rolled iron beams.

Fig. 3.



The introduction of this new description of beam, if properly prepared, would establish a new and important era in the history of constructive science, as it would supply architects and engineers with an article on which they might safely depend for durability and power of resistance to strain; which would not be liable to dry-rot, sap, or any of

Mr. Fairbairn on Machinery in General.

the destructive diseases to which timber is subject; and which would be free from oxidation when kept dry and imbedded in plaster. This is shown by the construction of floors in constant use in Paris.* Besides, a building so constructed possesses the advantages of being fireproof, strong, and secure.

Sectional form of iron beams not sufficiently attended to.

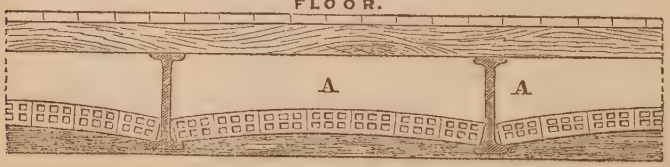
In the manufacture of malleable iron beams in France, sufficient attention has not been paid to form, in order to attain the section of greatest strength. The French philosophers and engineers are fully aware of the experiments made in the year 1845, for investigating the strength and form of iron beams, in order to establish the principle on which the Britannia and Conway tubular bridges should be constructed. The formulæ deduced from these experiments are well known in France, and up to the present time have been used for similar constructions. They proved that wrought iron beams followed a totally different law in their resistance to strain, to cast iron; that in wrought iron beams the area of the bottom flange requires to be little more than one-half that of the top; while in cast iron beams the area of the bottom flange should be *six times* that of the top flange. This difference arises from the great resistance which wrought iron offers to a tensile strain, and its compa-

* It may here be stated, that the floors of all the better class of houses in Paris are now built with iron joists, placed at distances varying from two feet to two feet six inches asunder. Some of these floors supported on iron joists are 30 feet wide. At about every three feet six inches cross tie-rods are placed, on which rest slender wrought-iron rods half an inch square, three between each joist; these rods are run through perforated bricks of the annexed sectional form (Fig. 4.) These bricks are built in a slightly arched manner, and the space below them filled with plaster, forming a perfectly solid floor. Across these rods and arches wooden sleepers are placed to receive the boarding for the floors, leaving a hollow space between each joist, as at A A (Fig. 5.) In this description of floors there is every security from fire, and the plaster being a bad conductor of heat, equalizes the temperature of the room. The only objection is the open space A A (Fig. 5), between the arches and the boarding, serving as a receptacle for vermin. This objection might be removed by divisions of plaster six inches thick carried across the floor, and in contact with the boards. This description of building is in general use in Paris and most other towns of France, and viewing it as a permanent fireproof structure, I should earnestly recommend its adoption in this country.

Fig. 4.

FIG. 5.

FLOOR.



CEILING.

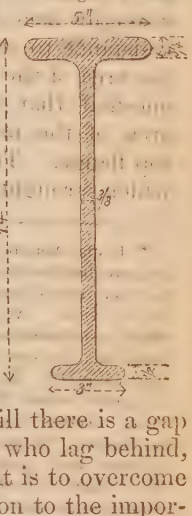
ratively inferior resistance to compression. Cast iron, on the other hand possesses a high power of resistance to compression and defective resistance to tension. The following Table of resistances will show how the material should be distributed in order to obtain the maximum of strength with the minimum or least required quantity of material:—

The resisting power of—

	To tension, in tons.	To compression, in tons.
Wrought iron plates is	23	12
Copper ,,	16	3
Cast iron ,,	8	51

From the above it is evident that to obtain the maximum strength in a wrought iron beam from the least quantity of material, the area of the top flange should be nearly double that of the bottom: but as this is difficult in practice, I submit the annexed form as the nearest approach to a maximum sectional strength. It is desirable to make the top flange as broad as possible, for the purpose of giving the beam lateral strength, and in this form the useless material now given to the botton flange would be saved.

Fig. 6.



Superiority of our railway bars.

In other descriptions of manufacture, such as railway bars, angle-iron, T-iron, and other varieties, we are in advance of other nations, though in beams and joists like those so extensively used in France, we are far from perfect; and although this may be owing to the want of demand rather than of skill on the part of the iron manufacturers, still there is a gap to fill up, either on the part of the architects who lag behind, or in difficulties raised by those whose duty it is to overcome them. In conclusion, I would direct attention to the importance of the assertion that Great Britain should never be behind in *any* description of manufacture which leads to the extension and enlargement of her iron industry.

Necessity of improving our manufacture of iron beams.

Other branches of industry.

Mr. Fairbairn on Machinery in General.

On Architecture and its Progress.

Decline of architecture in England.

Before entering upon the question of machinery, it may not be uninteresting to examine as briefly as possible into the present state of architectural science, and the changes that are taking place both in the style and the material of construction. The architecture of Great Britain has probably never, since the days of the old Norman Gothic, been at a lower ebb than that indicated by the architecture of the last two hundred years. The low state of the decorative art, and the paltry appearance and total want of taste in the buildings of that period sufficiently evince the decline of the high sentiment in the combination of material which constitutes the beauty and symmetry of architectural design. It is true that the country can boast of some distinguished exceptions among the architects of the past and the present day; but the works of the founder of the Adelphi, and the builder of Buckingham Palace, are not to be compared with those of Inigo Jones and the high art and classical style of Sir Christopher Wren. The art of beauty and proportion in architecture appeared to be almost lost, with probably few exceptions, during a great portion of the last and a part of the present centuries; and it is only within the last twenty years that the profession gives indications of its recovery from the state of degradation into which it had fallen. The country is indebted to Pugin, Sir C. Barry, Cockerell, and other leading men for the improvements which have been effected, and also to some of the junior architects of the present day for the revival of a better and more consistent style of decorative art.

Superiority of the French architecture.

The impressions produced on my mind when viewing the improvements now in progress at Paris were, that we have yet much to learn in this refined and classical art; and although the cheapness of the material, and facility with which it can be worked, be admitted, we are nevertheless still behind the architects of that country in attention to the harmony of proportions and to those laws which constitute the difference between high art and incongruity of form.

I do not offer these observations as opinions, but simply as impressions forced upon me in the contemplation of decorative art as it appeared at Paris during my residence in that city. On the other hand, it is but fair to consider the difference of material at the command of the architects of Great Britain and of those of France. If we compare the light appearance of the buildings and the clearness of the

atmosphere of France with the red brick, dingy stone, and the coal smoke of the Metropolis and our large towns, there is evidently an advantage in favour of the Continent for architectural display, and it is only an act of justice to make these admissions: but allowing for all the advantages of difference of colour and difference of quality in the material, there is still great room for improvement.

Iron as a building material.

That brick buildings can be made perfectly architectural by a judicious arrangement of stone in combination, I have not the shadow of a doubt; and now that iron is coming into general use as a new and important material to be turned to account in the construction of buildings, it will not, I trust, be considered presumption if I recommend the consideration of its properties to the attention of the architect and builder. Its durability, superior strength, and fitness for building purposes have already been demonstrated;* and I am satisfied that the enterprise, intelligence, and good sense of our architects will at once perceive the advantages of its extended application.

In floors, roofs, and domes for public buildings it is incomparably superior to timber, and provided architects and builders of dwelling-houses would look more to security from fire, and durability, than to cheapness of construction, they would not only erect very superior structures, but would hand down to their successors buildings of a very different character to the rickety structures in which the poorer and some of the middle class of society now reside.

It is always an unpleasant task to animadvert upon the customs of any particular profession, or on what may be considered material defects; but having been requested to give my impressions fresh from the anvil of the Paris Universal Exhibition, I should ill perform that duty if I disguised the sentiments which that visit has produced. I have not, therefore, hesitated to point out wherein consists our deficiency, nor is it my intention to withhold what I am bound to admit, that in this country we are rapidly approaching a new era in the history of architecture; and, considering what has already been accomplished, I am satisfied that our past failures will not be lost upon our future success. The buildings now in progress indicate a totally different character to those which were rising into notice twenty or thirty years ago. Cheapness is not now so much the order of the day. Security, permanency, and beauty have taken the place of the false and depressed style of

Improvement in English architecture of the present day.

* *Vide* a Work lately published by Weale, "On the Application of Cast and Wrought Iron to Building Purposes."

Mr. Fairbairn on Machinery in general.

former times, and we may reasonably look forward to a generous rivalry in all the requirements of architectural decoration and solidity of construction. These are steps in the right direction; and the architect of the present day has only to persevere in the course already begun, and an improved taste for classical harmony and symmetrical proportion will shortly pervade the public mind, supplant past errors, and ultimately lead to important results.

Employment of iron as a building material in France.

In conclusion, I would again venture strongly to recommend that more attention should be paid to iron as a building material; its durability and its powers of resistance under the varied forms of columns, joists, and girders are too well known to require repetition in this place. I would therefore point out a few examples of its successful application; and seeing what has already been done on the Continent, I entertain hopes that the time is not far distant when in this country also it may come into more general use.

The French availed themselves of the experiments which resulted in the completion of the Britannia and Conway bridges,* to apply them to similar structures; and nearly the whole of the bridges of large span, particularly those for the support of railways and heavy traffic, are constructed of this material. In France single plate girders are chiefly in use, and these united to cross-beams of the same material for supporting the platform of the roadway, answer every purpose of a strong and perfectly solid structure. The wrought iron beams also are most extensively used to support the floors of dwelling-houses, and the Government engineers have used the same metal with great success in the construction of flat arches of wide span. In structures of this kind, it may be noticed that the bridge, by M. Oudry, across the Seine, between the Church of Nôtre Dame and the open space in front of the Hôtel de Ville, has very recently been completed on that plan. To these, to the Exhibition buildings, and to the plate roof so beautifully constructed over the Terminus of the Paris and Versailles Railway Station, I may refer as examples where the French have been as forward as any other nation of Europe in availing themselves of the benefits to be derived from a judicious application of wrought iron to architectural purposes; and the very high price of this material in that country has not deterred them from its free and liberal employment.

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* *Vide* the experimental researches in my Work on the Conway and Britannia tubular bridges.

In England we have the merit of its first application to ship-building, bridge-building, and similar works of great magnitude; but we have not pursued its application to the constructive arts with the same energy as has been done by the architects of France; and although we can exhibit some splendid specimens of roofs, ships, and bridges, we have much less to show in the shape of building and other varieties of construction, so successfully adopted by the architects of other countries.

Employment of iron in Prussia, Austria, &c.

In the Prussian, Austrian, and the smaller German States, iron is employed in the lattice form for bridges, but I have not seen it much in use, and also to a very limited extent, for the purposes of building, excepting probably at Berlin, where it is successfully used for girders, and the construction of domes for public buildings.

Employment of iron in England.

Bridge-building has always been the chef-d'œuvre of the building art, and I was much struck by the cheap and solid form of some of those across the Seine at Paris. Our bridges over the Thames are composed of a solid mass of granite, but in Paris they have only an outside veneering of cut stone, the whole of the interior or filling up, as shown at A A, Figure 7, being composed of a species of concrete or rubble closely grouted with plaster of Paris or cement. (See engraving on next page.)

Bridges of Paris.

This cement when dried forms a perfectly solid mass for resisting the thrusts of the arches. The new bridge which crosses the Seine at the end of the Annexe and the Beaux Arts is of this description, and I am assured that most others in that city are composed of the same material.

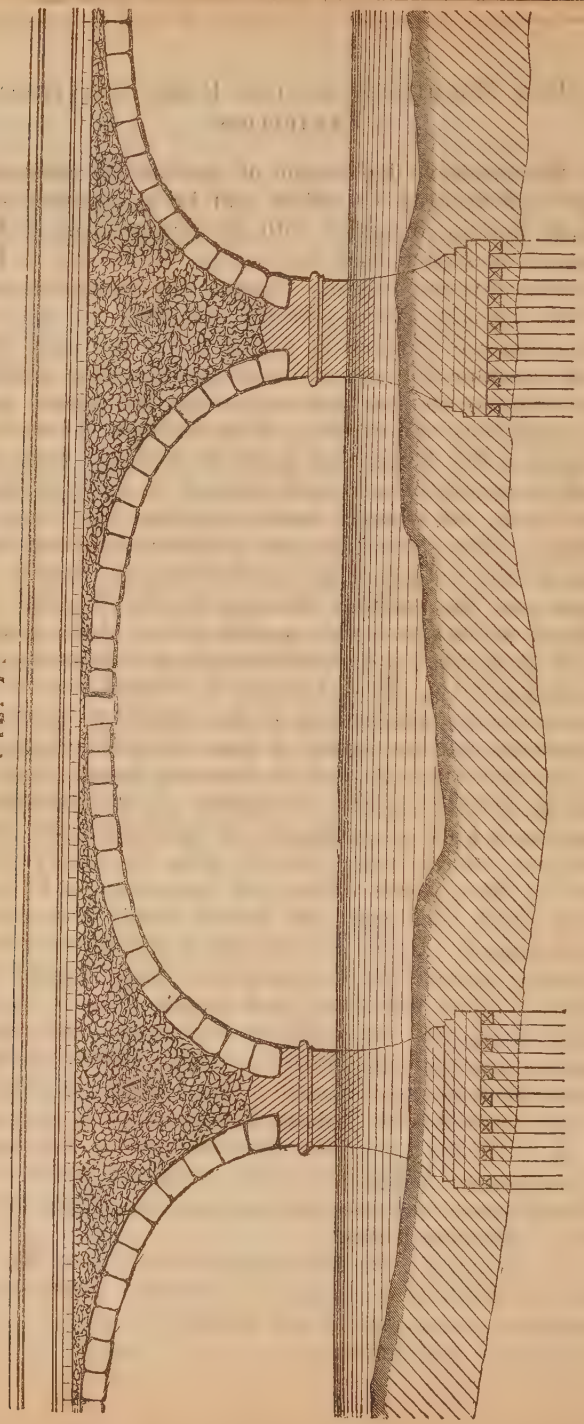

FIG. 2.

The Machinery of the Paris Universal Exhibition.

Mr. Fairbairn on Machinery in general.

My intention as to this department.

In this extensive department of mechanical construction, I have endeavoured to collect and bring together such a series of facts in connexion with the various forms and adaptations of the objects that have come before me, as I trust may prove advantageous in extending the industrial pursuits in which this country is so largely engaged. In the classification that was adopted the Jurors might probably be expected to confine their observations to the articles specified in their respective classes; but conceiving that a more general and comprehensive description of the mechanical contrivances displayed in this Exhibition might be useful, I have endeavoured to record them in such form as to show in what we are deficient, and wherein consists our superiority over other countries. The Paris Universal Exhibition differed from all others in the extent of its productions, the variety of its objects, and the facilities afforded for the disposal of the exhibited articles at a fair market price; these conditions were of great value to the exhibitors in the immense selection submitted to view. In this respect it differed from the Exhibition of 1851; and looking at the numerous specimens of raw material and the display of manufactured articles, we at once conclude that it was an immense bazaar, from which might be selected every description of manufacture and almost every kind of produce. In this Exhibition nothing struck the observer more forcibly than the beauty and the extent of the articles offered for inspection, and the great skill by which such vast and varied forms of manufacture were produced. In the department of machinery it may be interesting to trace the development of many ingenious contrivances. The self-acting and almost creative power of machine tools, and the facilities with which that branch of manufacture is endowed for the production and reproduction of other machines, is a feature of incalculable importance to the national industry. Many of those now in constant use had no existence a very few years since; but such has been the progress in mechanical science, that the finish of work performed many of these machines surpasses the most skilful efforts of the human hand.

Differences of the Paris and London Exhibitions.

Advantages of self-acting machines.

Such, in fact, are the advantages derived from the introduction of this kind of machinery, that the produce of our manufactures is multiplied and extended ten and in many cases upwards of a hundred fold. In the process of copying, or the reproduction of the same article by mechanical means,

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there were in this Exhibition numerous contrivances, for which we are indebted to the Americans, and their system for the formation of objects by *dummies*, or what may be called the pantagraph system, by which the form of every part of the object is traced, and by proper tools and cutters a fac-simile of the article to be copied produced. This system of reproduction is fast coming into general use, and many examples of its utility were shown at the Paris Exhibition.

Steam Engines and Steam Machinery.

Enumeration of the steam engines exhibited at Paris.

The number of steam engines in the exhibition was 112, consisting of 71 stationary, 24 marine, and 17 locomotives, as follows:—

	Stationary.	Locomotives.	Marine.
France	25	6	11
Great Britain	11	2	11
Austria	11	1	—
Prussia	1	1	—
Belgium	1	3	—
Hanover	—	1	—
Wurtemburg	—	2	—
Baden	—	1	—
Sweden	11	—	1
United States	11	—	—
Holland	—	—	1
Total	71	17	24

Stationary Engines.

Vertical engines in France, Belgium, &c.

Their boilers.

The department of stationary engines comprised almost all the varieties of construction, horizontal, vertical, and oblique. The horizontal with one cylinder appears to be much in demand, and the vertical with two cylinders upon Woolf's principle, having an expansion from four to five times the volume of the small cylinder, has been for the last half century in general use in France, and almost equally so in Belgium and most other parts of the Continent. They are worked generally at a pressure of 40 lbs. to 50 lbs. on the square inch, and the steam is supplied from boilers with the fire under two longitudinal tubes or generators. These tubes are connected with the boiler at both ends, and the heated currents having made two or more circuits of the boiler, make their escape to the chimney in the usual way. These boilers are not, in my opinion, superior in the economy of fuel to those with internal flues, or to the tubular system as constructed in this country; but their power of resistance to internal pressure is greater than in boilers of the English construction.

Horizontal engines; their advantages.

The single-cylinder horizontal appears to be gaining ground upon the double-cylinder vertical engine, and, doubtless, this arises from their reduced cost. Their compact form, and the limited space which they occupy are considerations of some importance, and now that metallic pistons are so accurately constructed, the wear and tear upon the cylinder is greatly reduced. The condenser in this construction is placed below the cylinder, and the air pump is worked by a lever attached to the cross-head of the connecting rod and horizontal slides. The air pump, like the cylinder, is placed horizontally, and various forms and devices are adopted in order to give the required motion to the feed-pump, and other organic parts of the engine. As an example, the annexed engraving will convey a pretty accurate idea of the arrangement generally adopted in this description of engine, and the methods employed for working the air pump and feed pump. In this construction A is the cylinder; B, the condenser; C, the air pump, worked with a solid piston; and D, the feed pump. The lever E receives motion from the links attached to the cross head and slide at F; and in order to produce a perfectly horizontal motion in the connected rods of the air pump and feed pump, the oscillating lever E is suspended by two more links at *a*, which leave it free to slide up and down at the foot *b*, and thus a horizontal movement is effected in the two pump rods before mentioned.

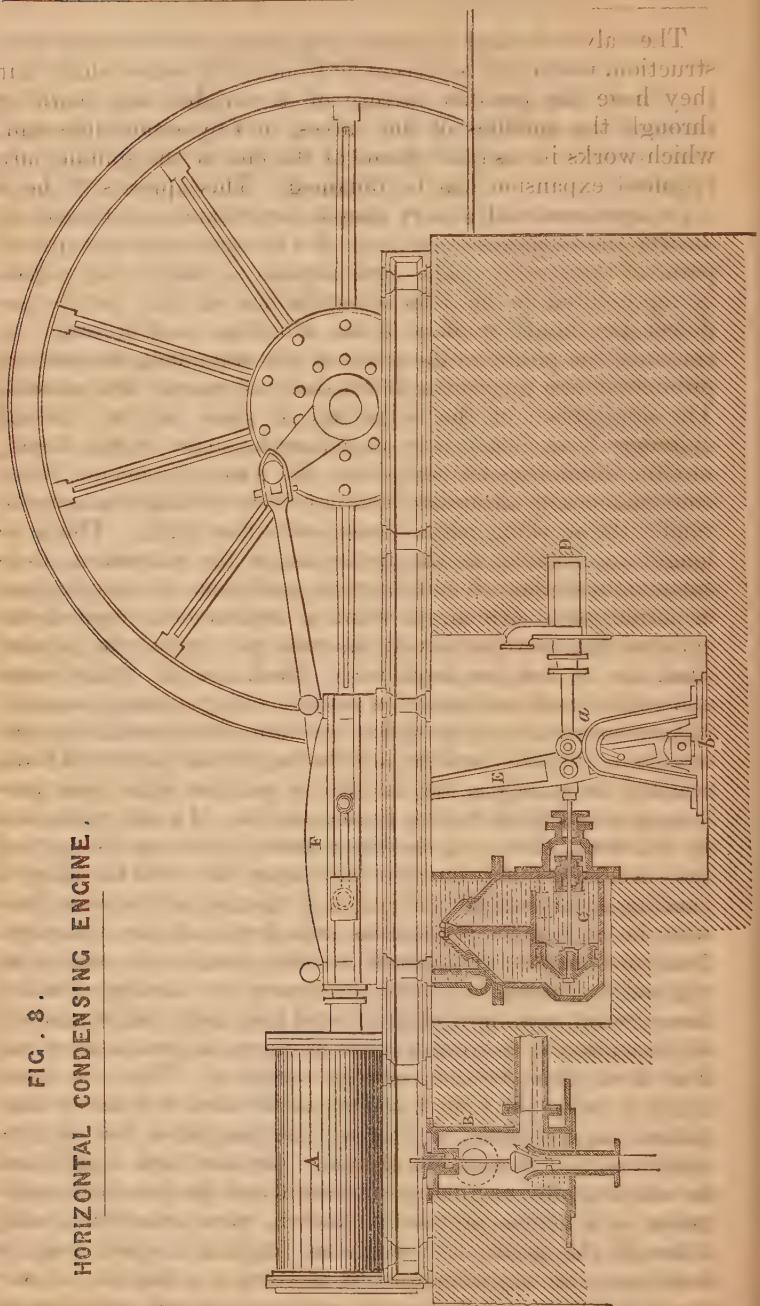

FIG. 8.

HORIZONTAL CONDENSING ENGINE.

The valves in most of those engines are of the usual construction, worked by an eccentric from the fly-wheel shaft, but they have the peculiar feature of a variable lap, working through the spindles of the valves, and by a moveable cam, which works in a square frame at the end of the spindle, any required expansion can be obtained. This appears to be a very ingenious and a very simple contrivance, and seems to answer the purposes of cutting off the steam at any required point of the stroke. The consumption of coal in this engine is represented to be 1·36 kilogrammes of coal per horse-power per hour, or about 3 lbs. English; and in order to convince the public of the truth of this statement, the makers publicly offer a guarantee that it shall not exceed that amount. The application of the horizontal in place of the vertical cylinders is an idea nearly as old as the steam engine itself; but the difficulties formerly were the want of tools and other conveniences for attaining accuracy of construction in order to render the working parts smooth and steam-tight. This is no longer an obstacle, as the perfection of the automaton tools surmounts all those inconveniences, and hence the conceptions of former days, which, for want of instruments requisite for construction, have remained in *statu quo* up to the present time, are at last accomplished. Such are the retardations and such the advancements of science, one generation conceiving schemes and projects which, for want of the means, they are unable to execute; and the next having, in the process of time, realized those means, are enabled to perform what their predecessors had tried in vain to accomplish. In the realization of old ideas, there is generally a strong desire on the part of the successful practitioner to force upon the world his adopted bantling as an original conception, forgetting at the same time what he owes to his predecessor who first made the discovery. No doubt there is great merit in being the first to perfect an original invention, but there is no merit in claiming as a discovery what was known before; and this desire for originality of conception is as strong, if not stronger, in the minds of our French neighbours than among ourselves. There is great credit in being the first to render useful what was before considered impracticable, and he who accomplishes this is certainly entitled to acknowledgment. In the Paris Exhibition the claimants for originality of design, and the practical application of schemes previously known, were numerous; and, although the desire to become an original inventor may, in some cases, be objectionable, it nevertheless has its advantages in stimulating that active race to renewed exertions in furtherance of future developments in practical science.

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The horizontal likely to supplant the vertical form.

The horizontal engine on account of its reduced cost and compact form is likely to supplant the old vertical arrangement; and assuming the same rate of expansion to be in operation, and the steam to be cut off at one-fourth or one-fifth of the stroke, the result, so far as regards the economy of fuel, will be the same as that derived from the double cylinder. In this country these improvements, although well known, are not carried to the same extent as in France; and although the same kind of engine is in operation, we have made slower progress, excepting in the horizontal non-condensing engines, which in Lancashire have got the name of *Thrutchers*, and are now extensively used as an auxiliary power to the condensing engine in most of the manufacturing districts. There is, however, still wanting a well-digested arrangement of the horizontal condensing engine, compact in form, and adapted tot he work it has to perform: the Paris Exhibition presented numerous examples for our guidance.

Locomotive Engines.

English engines.

The locomotive engine had its origin in this country, and those of English origin still retain their superiority over all others, both in design and construction.

Foreign engines.

It would, however, be unjust not to accord great merit to the many excellent specimens contributed to the Paris Exhibition by Continental nations. Nearly all of them were somewhat complex in arrangement and design, but evincing great care and attention to solidity of construction. Many of the engines were upon the system of Crampton, with the valve motions outside, which gives to the engine an appearance of complication that does not occur in those of English construction. In other respects the engines are the same as our own, with the link motions and other indispensable attachments.

The "Eugénie."

There was, however, one engine to which I would refer—"the Eugénie," built on Mr. MacConnell's principle of the large firebox and short tubes. This and another from Messrs. Stephenson and Co., of Newcastle-on-Tyne, were the only English locomotives exhibited; and considering the large number brought forward by our Continental competitors, the English constructions were very imperfectly represented. Mr. MacConnell's engine is on the same principle as the large goods and express engines now working on the London and North-western Railway. They have several valuable properties, which it may be useful to enumerate in connexion with the experimental trials made with the "Eugénie"

on the London and North-western Railway, the results of which are as follows:

Principal Dimensions of the Engine "Eugénie."

Diameter of cylinders	15 in.	Diameter of boiler	4ft.
Stroke of piston	22 in.	Length of barrel of do.	10ft. 6in.
Diameter of driving wheel	7 ft.	Length of fire-box	3ft. 9½in.
Heating surface, fire-box, &c.	159 sq. ft.	Number of tubes	414
Tubes	731sq. ft.	Length of tubes	6ft.
Weight of engine in working condition	21 tons 18 cwt.	Outside diameter of tubes	1¾in.

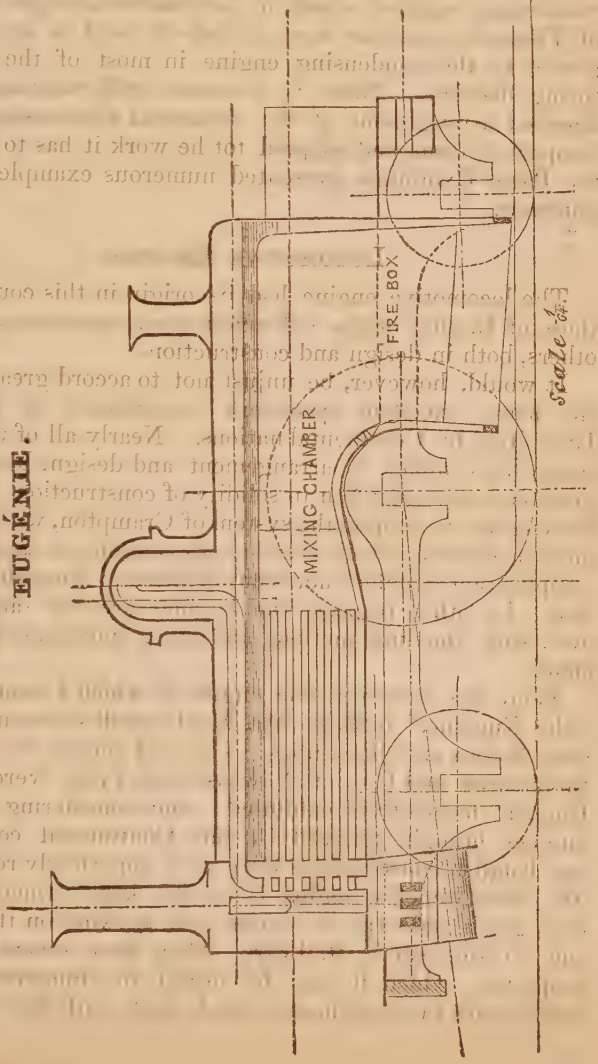


FIG. 9.
LONGITUDINAL SECTION OF THE EUGÉNIE.

Mr. Fairbairn on Machinery in General.

Results obtained during Three Weeks' Running on the London and North-western Railway, on a Course of 83 Miles with Express Trains.

	No. 1 Trial.	No. 2 Trial.	No. 3 Trial.
Number of carriages - -	15	12	9
Total Weight - -	75 tons.	60 tons.	—
Coke burnt, per mile - -	19 lbs.	15 lbs.	—
Speed per hour - - -	40 miles.	45 miles.	75 miles.
Ratio of evaporation of water to coke	8·90	8·75	—

In these experiments the engine ran with perfect steadiness in all its parts, and can make a journey of 55 miles without stopping.

This engine burns coal of the worst quality without smoke, and with great economy; the generation of steam is most powerful and regular, both at high and low speeds. The arrangement of the furnace and large mixing chamber effects the combination of the gases, so that there is no smoke, and permits the use of a much larger number of smaller tubes, so as to give a tube surface of the same extent as in the ordinary arrangement, but of much greater efficacy. The curve or recess employed in the cylindrical part of the boiler, as shown in the annexed sketch, is of great advantage for forming a metallic bridge between the fire-box and mixing chamber, where the gases are combined, and where it is easy to admit hot or cold air in sufficient quantity to complete the combustion of the gases disengaged from the fuel. This hollow curve adds also to the steadiness of the engine by lowering the centre of gravity, and producing the same if not greater advantages than are obtained by the use of outside cylinders.

Similarity of all locomotive engines.

It would be invidious to draw inferences or to make comparisons on the construction of machines that are so exactly similar in character and almost identical in principle. The locomotive engine is the same in all countries, and however varied in form or construction, it invariably consists essentially of the blast pipe, tubular boiler, and outside or inside cylinders.

Improvements have been slight.

Some slight additions and improvements have been effected in the different motions and organic parts of the engine; but they all resolve themselves into enlarged heating surfaces in the boilers and the employment of the exhaust tube, which is, in fact, the bellows that blows the fire and maintains the supply of steam under every circumstance and every velocity at which the engine may travel. In every construction of this kind the following conditions must be observed, namely, the proportions of the furnace, tubular surface, and the blast pipe; and these once accomplished, the mere form of construction becomes a consideration of less importance.

Doubtless much has been done in proportioning the working parts, such as the wheels and axles, motions, connecting rods, &c., to the work they have to perform, but nothing more is apparently left to be accomplished unless it be to increase the pressure, and by an extended expansion to effect greater economy in the consumption of fuel. The foreign engines exhibited in the Annexe were substantially made, and some of them too much so, as a considerable amount of weight and expense might have been saved in the reduction of the material where it is not wanted, and where it does not add to the strength of the engine. In the foreign engines there appeared to be a want of accurate proportion in the distribution of the material, and of simplicity in the movements; and having had some experience in the construction and proportion of the parts, I am probably the more able to judge of their comparative merits. Under all the circumstances, I am, however, of opinion that the locomotive engines of Great Britain are superior to most others, and although they may not have the same amount of exterior polish, there is, nevertheless, a simplicity of form and a soundness in the workmanship that gives a character and stability that cannot be mistaken.

Superiority of English locomotives.

Marine Engines.

In this department there was little to recommend, as the contributions were very scanty, and will not bear a comparison with those that were exhibited at the Crystal Palace in 1851.

Scantiness of the contributions to this department.

With the exception of a pair of neat engines from the Mortala Works in Sweden, two pairs from Cail and Co., and a small pair from Tod and M'Gregor, of Glasgow, constructed for the screw propeller, there was nothing except some models that deserved the name of marine construction. The rest were not of the best or simplest forms, and cannot, therefore, be considered of much value, either as regards design or construction.

It is to be regretted that owing to the exigencies of the war, and the great demand for marine engines, that the English makers were unable to forward any for exhibition. In 1851 the Crystal Palace was supplied with some splendid specimens of marine construction, and we have only to enumerate those of Boulton and Watt, Penn, Napier, Maudslay and Field, and others, to be convinced of the superior description of construction for which the British engineer is so justly famed.

The exigencies of the war prevented the English makers from exhibiting.

It will be fresh in the recollections of all those conversant with the steam engine, that considerable advances have been made of late years in the use of steam worked expansively and at high pressure. This has been strikingly exemplified in every description of engine, and it is evident that whether of land or marine construction, the tendency is to increased pressure. That increased pressure, when accompanied by a

Application of high pressure steam worked expansively.

Mr. Fairbairn on Machinery in General.

more extended expansion, is invaluable as an element of power, and economy in the consumption of coal, and the greater the length through which the steam is worked expansively the greater the benefits to be derived from its application. I have no doubt that the experiments of Regnault on steam, and those of Joule on heat, and work done, will ultimately lead to a new and more extended application of this principle.

All that is wanted in this new application will be the construction of boilers of sufficient tenacity to resist from four to six times the pressure at which it may be prudent to work the steam, and with these precautions, I see no reason why we might not reduce the weight of our engines and increase the pressure of our steam up to 100 lbs. or 150 lbs. on the square inch.

Hydraulic Engines and Machines.

Employment of the turbine in foreign countries.

The turbine appears to have almost entirely supplanted the water-wheel in the estimation of the French engineers and manufacturers; and the millwrights availing themselves of the Universal Exhibition have contributed a great variety of articles of this kind. In many parts of France, Switzerland and Germany, particularly in the mountain districts, where fuel is expensive, the turbine is of great value, and in many parts of the country where water and high falls abound, it is a more convenient and a less expensive machine than the water-wheel.

Comparative merits of turbines and water-wheels.

On the subject of turbines and their comparative economy, there exists, however, considerable difference of opinion, the advocates for the turbine contending that they are as effective as the water-wheel, and yield from seventy to eighty per cent. of the theoretical work of the fall; others again asserting the superiority and economy of the water-wheel. In my own experience, I have found the work done by the turbines to range from fifty to sixty per cent. of the work due the the fall, and in some cases as high as sixty-five to seventy per cent.; but they are certainly not so effective as the breast wheel, which, when well constructed, yields from seventy-five to eighty per cent; in the turbines there is, however, a considerable reduction in the first cost of the machine, and looking at their great velocity when propelled by high falls, and their relative weights, they are certainly preferable to water-wheels under certain conditions and in some localities. In other respects where the fall of water does not exceed fifty feet, the water-weel will be found to possess, as far as my experience goes, considerable advantages over the turbine.

Hydraulic machines in England.

The hydraulic machines of this country have been almost exclusively confined to the water-wheel and the hydraulic

engine for raising water from mines. This latter engine is worked by a head of water, which by its initial force raises a piston or plunger in a cylinder, and by opening a valve when the length of the stroke is attained, allows the water to escape, and the weight of the mass raised reacts upon the plungers in the pit and raises the water in the usual way by the plunger pump. This is a very simple machine, which may be applied in mountainous districts where high waterfalls exist.

Hydraulic engine.

The water-wheel has maintained its ground from time immemorial against every new invention and all competition; and I am persuaded that for simplicity of form, durability of construction, and economy of action, it still retains its claim to importance. It has received many improvements, first from the experiments of Smeaton, the constructions of Rennie and Hewes, and still more recently, from myself. The experiments of Smeaton first determined its relative powers when employed on high and low falls. The late Mr. Rennie improved its construction and the mode of applying the water: and Mr. C. Hewes of Manchester was the first to apply and perfect the flexible malleable iron radius rods to the shrouds or periphery in place of arms.

Water-wheel.

All these inventions, including my own for ventilating the buckets and working wheels to greater depths in back water, have contributed to make the water-wheel one of the most economical and perfect machines now extant.

The researches of Poncelet showed the best form and curvature for the buckets; and it would be ungracious to deny that the turbine itself would never have existed in its present state of perfection but for the sound principles first promulgated by that distinguished philosopher, in his lectures on hydraulics and hydrostatics. Altogether these machines were well represented in the Exhibition, and although they are comparatively useless in Great Britain, where the steam-engine is so extensively employed, yet on the Continents of Europe and America, where water is plentiful, they are of great and paramount importance in the pursuit of the industrial arts.

Machinery for the Manufacture of Cotton, Silk, Flax, and Wool.

It would ill become me to attempt any description of machines used in the manufacture of the textile fabrics, when it is known that the much abler pen, of Professor Willis, of Cambridge, has undertaken that duty: suffice it to observe, that in the French, Belgian, and Zollverein departments of this description of machinery, several excellent specimens were to be found. Some of them were highly finished; and

Foreign specimens exhibited.

Mr. Fairbairn on Machinery in General.

the new combing machine made by Messrs. Schlumberger and Co. appeared conspicuous for its ingenuity, and the efficiency of its operations. This machine has been greatly improved by Messrs. Hetherington and others since its first introduction into Manchester and Bradford, and in the preparation of cotton for fine yarns it is one of the most valuable machines that has come into use for many years. In the combing of flax and wool it is becoming equally important, and its application to the manufacture of the long wool, alpaca, and mohair fabrics of Bradford, has at once established its superiority over the system of carding and combing by the old process. The contributions of machinery from the hands of such men as Platt Brothers and Co. and other English firms are sure to be of unrivalled excellence. Several improved machines for the manufacture of cotton, of the best construction, were to be seen in the space occupied by the English. Messrs. Platt, Brothers and Co. contributed a complete system of cotton machinery; and Messrs. Elce and Co., of Manchester, did the same, with the exception of the blowing and spreading machines, which were not sent. Mr. Mason, of Rochdale, also contributed several exceedingly well made machines.

Excellence of English contributions.

Scanty representation of English machines for the manufacture of flax and silk.

The machinery for the manufacture of flax and silk was, however, very imperfectly represented in the English department, and with the exception of the samples of yarn, there was nothing to point out the superiority of machinery in those branches of industry. This is much to be regretted, as for many years past we have taken the lead in the flax and the silk manufacture, and large quantities of machinery for both have for the last fifteen years been exported to France and many other kingdoms of Europe. Mr. Peter Fairbairn, of Leeds, a large constructor of flax machinery, stands prominently forward as having effected the greatest improvements by his contributions to the perfection of these machines: in fact, his machinery is to the flax manufacturer what Mr. Whitworth's machine tools are to workshops. The reason assigned by him for not exhibiting was the enormous expense of showing his very extended series of machines to advantage.

Flour Mills.

Old forms of flour mills.

Thirty years ago the flour mills of France and most other parts of the Continent were of rude construction, and exhibited few traces of improvement from the constructions of the previous century. The corn mills in England, Scotland, and Ireland had also been nearly stationary up to the same period of time, with the exception probably of some changes and improvements effected by Smeaton and the late Mr. Rennie.

At the close of the last or about the commencement of the present century the Americans and ourselves introduced the system of creepers and elevators, by which a considerable amount of labour was saved, and the operations of grinding rendered more complete. From time immemorial it has been the custom to drive the millstones from a large spurwheel in the middle of the mill, round which they were placed. This arrangement of the grinding process is still in use in many parts of France, and several exhibitors have given examples of some of their best mills on this principle. Like those of this country they are nearly all of them continuous in the process of cleaning the grain, grinding, and dressing the flour.

French mills exhibited; the stones placed in a circle.

The millstones are generally driven by straps or belts, whilst those in England are almost invariably driven by gearing. It is upwards of thirty years since Messrs. Fairbairn and Lillie, of Manchester, and some others in Yorkshire, first introduced the new system of placing the stones in a line, driven by bevel gear along one side of the mill, and by this arrangement affording considerably increased space for the convenience of stowage and other purposes required in the manufacture. On this plan some of the best mills are now constructed; and although they differ from the French method of driving the millstones by straps, they nevertheless work with less power, are in many other respects preferable, and they do not crowd the room with belts in positions crossing the mill in almost every direction. It has been asserted that the straps are less expensive and give a smoother motion, but of this there is much doubt, as the gearing, when properly constructed, is found to work perfectly smooth, and is less troublesome than straps.

Introduction of gearing in England; the stones placed in a straight line.

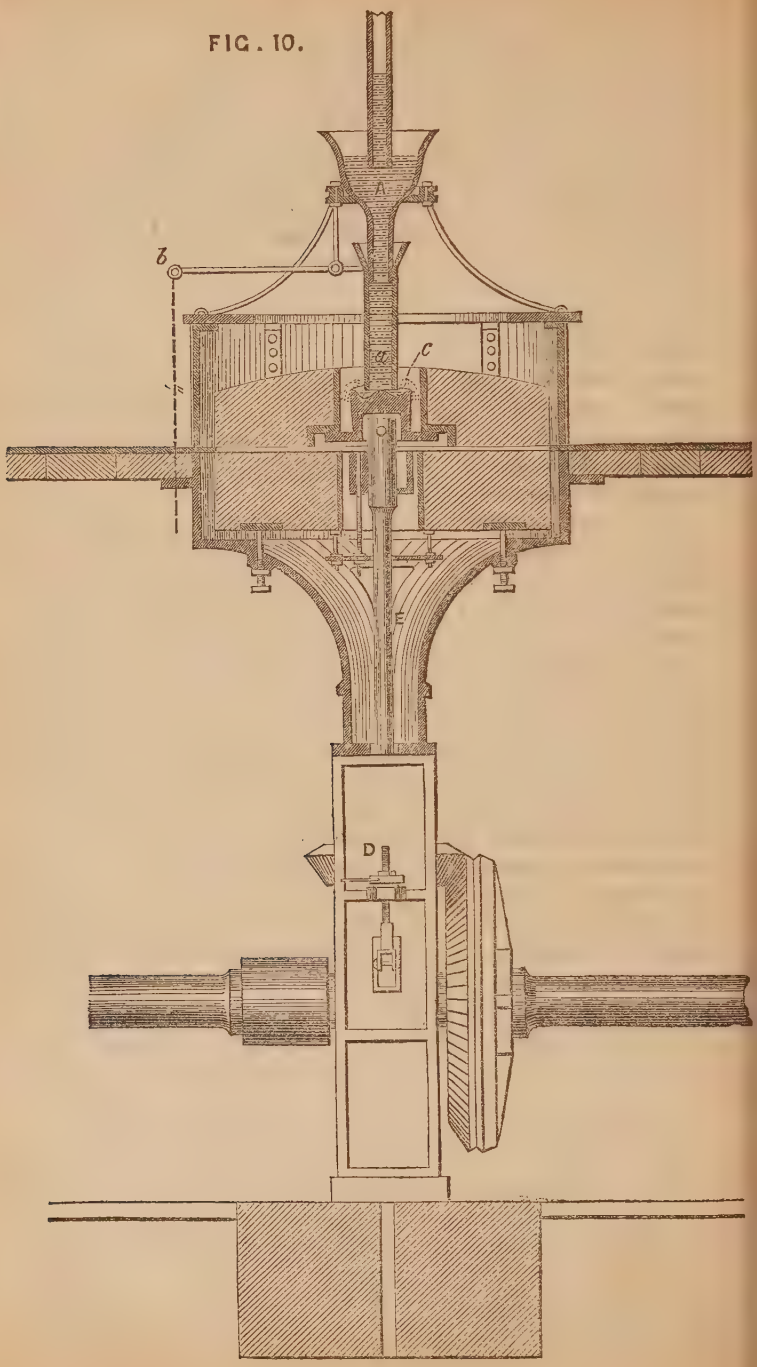
The old method of feeding the stones was by a slide or spout at the bottom of the hoppers. This was a little inclined, and acted upon by what is technically called a "damsel," or, in other words, by a small spindle fixed upon the centre of the running stone, which passing upwards in the direction of the hopper, acted upon the slide by three projections or tappets, and gave it a noisy, shaking motion.* This motion, and the rate of inclination at which the slide is fixed, gave the supply or required feed of grain to the stones.

Old method of feeding.

About the same time, or shortly after the introduction of the plan of placing the stones in line, Messrs. Fairbairn introduced their new feeder, shown in the annexed Cut, (p. 95), which exhibits a section of a pair of millstones, with a portion of the stone floor, hoppers, case, &c.

* The damsel was substituted for the "clapper," which in ancient times consisted of a piece of wood suspended from the upper frame rope over the millstones, which at every revolution received a blow from a tappet fixed into the back of the stone, and thus produced the rattling motion for feeding the stones.

FIG. 10.



By this arrangement the stones are fed from the hopper A by the tube *a*, about two inches in diameter, which conveys the grain into the cup *c*. This tube is suspended on the point of the lever *b*, and is fixed within a quarter of an inch from the bottom of the cup. As the millstones revolve, the cup goes round with it, and the tube being stationary, the grain escapes from below by centrifugal action, and is scattered as a thin stream over the edge of the cup, in a beautiful series of oblique, tangental currents into the eye of the stone.

Mr. Fairbairn's silent feeder.

This has been called the silent feeder, owing to the total absence of noise. The quantity of feed is regulated by raising and lowering the tube by the lever *b*. The lower part of the figure represents the horizontal shaft, and the mode of driving the stones, as also the screw D, that regulates the lever on which the spindle E and the running millstones are supported.

The contributions to the corn-mill department were numerous and interesting, and the contributors showed no small degree of skill in the numerous forms and devices by which they respectively recommended their machinery to public attention.

Burdon's flour-mill.

A flour-mill, by Burdon, of five pairs of stones, and driven by a turbine, on the principle of Poncelet, deserves especial notice, from the novelty of its design and the facility with which the stones can be stopped and started. The turbine with its cistern is placed below, in the centre of the stones, five in number, and the main shaft or spindle penetrates the first floor, and from thence ascends to the top of the mill, and in its passage gives motion to the different machines for dressing, cleansing, and elevating; it is, however, doubtful whether the novelty of this arrangement does not consist more in the ingenuity of the contrivance than in its utility.

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Special Machinery and Apparatus for Workshops.

Submitted to the adjudication of the Jury in Class VI.

The articles submitted to the adjudication of the jurors of Class VI. comprise a collection of such varied forms and character as to render any enumeration extremely difficult, and the distances by which they were separated from each other rendered it still more troublesome to arrive at a just and correct decision. The almost innumerable articles in the Class caused a division of the labours of the Jury into sections, as follows:—

Division of the labours of the Jury.

1. The separate pieces of machinery and apparatus for workshops.
2. Metallurgic machines.
3. Machines used in the preparation of timber.
4. Machinery used in mining operations.
5. Machines used in agriculture and the preparation of alimentary substances, including machines used in non-metallic minerals.
6. Machines used in the chemical arts and those in connexion with dyeing and printing.
7. Machines used in the manufacture of metal.

1.—The Separate Pieces of Machinery and Apparatus for Workshops.

What this section comprises.

This section contained all descriptions of tools, screwing apparatus, copying and embossing presses, and implements of steel, iron, brass, copper, &c. In this section were assembled an immense variety of machines, which, from their magnitude, cost, and extensive developments, required the most careful attention.

The tools of Whitworth and others, and the machines for embossing, screwing, &c., were minutely inspected, and the opinions of the different members of the jury about them were given, with great judgment, on the spot.

Extent of this collection.

Some idea of the extent of this collection may be formed when I state that not less than 400 articles were submitted to adjudication, some of them of great value, of exquisite workmanship, and comprising some highly skilful appliances admirably adapted for the purposes they were intended to serve.

Mr. Whitworth's collection of tools, lathes, &c.

In Mr. Whitworth's collection, tools, lathes and slitting machines of gigantic dimensions were to be found, some of them weighing from 10 to 12 tons, and a large lathe for turning wheels, with four rests cutting on both sides,

with almost mathematical precision. These and others of smaller dimensions were neatly proportioned and admirably executed by the machine, and without the aid of the human hand, beyond putting the parts together. Nearly, if not the whole, of Whitworth's machines are executed in this manner; his screw-cutting machines, gauges, and other works are so well known as to require no further description than is necessary to point out their presence at the Exhibition.

Graffenstaden's collection of tools, machines, &c., for cutting and turning wood.

Next to Whitworth's tools and machines for turning and cutting metals must rank those of Graffenstaden, from the vicinity of Strasbourg, for cutting and turning wood. These machines are beautifully and substantially made: they are mounted on cast iron frames, and for ingenuity of design and perfection in execution they are not inferior to any other description of machinery in the Exhibition. Their morticing, boring and turning machines are admirably constructed, and the whole series appear to have been got up with the utmost care in order to meet the various requirements of every description of carpentry, cabinet-making, &c.

Specimens from America.

Others, from America and other places, some of them of great ingenuity, were also exhibited, but none of them equal to those of Graffenstaden for solidity of construction and harmony in the proportion of the parts. To the American mechanics and engineers we are indebted for many ingenious and useful contrivances in this department of industry. Their pantagraph or *dummy* machines are admirably contrived, and no nations have displayed more skill in the application of machinery to the cutting, carving, and shaping of timber than those of Canada and the United States. Their system of colonization and the clearing of forests have given them facilities, and suggested inventions for saving labour, that could only be attained in a country where labour was scarce, and timber was the chief material for construction.

2.—Metallurgic Machines.

What this department embraces.

This section embraces a large field of operations, such as the forging and rolling of steel, iron, and copper, the machinery for blowing, smelting, and the manufacture of other metallic substances, and all the instruments and machinery used in the conversion of the metals from their crude state in the oven into the manufactured article. Notwithstanding the great extent of the subject, and the number of machines which it includes, the Jury had not so much to do in this as in some other departments, as many of the machines, such as rolling mills, steam hammers, &c., were of great magnitude. Most of these were found exceedingly interesting, and evinced considerable skill in their adaptation to

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the attainment of the objects for which they were intended by the exhibitors. The Jury in this, as in other cases, exercised a sound discretion in the awards.

Tilts and steam hammers.

From the variety of tilts and steam hammers exhibited, it would appear that the construction of those engines has been much cultivated in France; and notwithstanding the improvements and ingenious contrivances introduced by its inventor, Mr. Nasmyth, the French appear to have kept pace with us in the use and application of this important machine. Lately Mr. Nasmyth has introduced, by the assistance of Mr. Wilson, of the Low Moor Iron Works, a new, exceedingly ingenious, and, I believe, a very simple contrivance for working the hammer. By this application any length of stroke, any amount of blow, and any amount of variation can be given by the operation of a single lever, and by this improvement the machine has attained a rapidity of action and of change of motion suitable to the powers of the engine, and the form or consistency of the articles under the hammer. These improvements have not as yet been introduced into France, but the employment of so many large and small hammers, most of them well made, evinces a rate of progress in the operations of the forge as great, if not greater, than some of our best performances in this country. In the construction of vertical "tups" or friction hammers, our Continental neighbours have made less progress, but they exhibited some clever contrivances in tilts, some by steam and others by tappets, driven by gear, and acting in the usual manner on the tail or hilt of the tilt.

French machines for the manufacture of nails inferior to the English.

Several French machines for the manufacture of nails were exhibited, but none of them indicated either novelty of conception or superiority of workmanship; on the contrary, I considered them inferior to the machines used for similar purposes at Birmingham and Wolverhampton.

Iron slitting and rolling machines, &c.

In the machinery for slitting and rolling iron there appeared to be nothing new excepting some beautifully constructed steel rolls, manufactured by Krupp, and others of the iron manufacturers of France.

Wire-drawing machines, &c.

All the other machines of this class, such as wire-drawing and cutting machines, were of the ordinary construction, with the exception of the American plate-cutting machine.

This machine consists of a strong cast-iron frame from nine to ten feet wide, having a steel plate along its outer edge on which the plate to be cut is fixed, and is held fast by a faller, that rests upon the upper side of the plate. On the upper side of the frame a revolving steel cutter traverses its whole length, and in its passage cuts the plate in a perfectly straight line corresponding with the edge of

the steel plate below. The circular cutter is an old invention, but its traversing motion is certainly new, and is effected by various ingenious contrivances. The travelling cutter, which requires considerable power when cutting thick plates, is driven by a strap over a pulley at the end of the machine.

3.—Machines used in the Preparation of Timber.

What this section comprises.

This section embraces every description of saw-mill, planing, morticing, and tenoning machines, carving and grooving machines, and all the tools, implements, &c., used in the preparation of wooden constructions. In this section were found a great number of interesting and instructive devices and adaptations, many of them of American origin, but greatly improved since their first introduction into European workshops. The treatment of timber, and the mode of seasoning, is a subject as yet not clearly understood; much has yet to be learned: and the Jury, fully aware of the difficulties which surround the question, entered into a careful inquiry as to the best methods now in use, and the most effective processes adopted in different countries for seasoning and rendering timber as strong and durable as possible under the varied conditions of quality and growth, and also the objects to which it can be applied. The Jury appeared perfectly alive to the consideration that different qualities of wood required in seasoning different treatment, each requiring a treatment that would consolidate their fibrous structure, strengthen their power of resistance to strain, and render them impervious to moisture and those atmospheric changes which so frequently affect the durability of structures composed of wood.

Seasoning of timber.

Saws, cutters, planers, &c.

Of the machinery, there were some excellent specimens in the shape of saws, cutters, planers, morticers, and groovers, which received careful attention, in order to guide the Jury in the award of the prizes and other marks of distinction to which the exhibitors were so justly entitled.

Saw-mills.

The most striking objects in this department were the saw-mills, and those of Mr. Norman, of Havre, stood pre-eminent for the ingenuity and skill with which they were executed. His vertical saw for cutting timber of any required form for ship-building was admirably contrived, and the moveable frame on which the timber was fixed exhibited a variety of motions for giving any degree of obliquity to the cut; and thus, for ship-building purposes, the required twist or form necessary to be observed in the bows or stern of the vessel was easily attained without interruption to the cutting process by stopping the saw. Another vertical saw driven by steam power, in imitation of the hand frame saw,

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and most ingeniously contrived, was also exhibited; its operations were very complete, and it formed one of a series of machines of great value in accomplishing the more intricate operations of cutting timber into shape. The steam saw frame of M. L. Schwartzkop, of Berlin, was also an exceedingly well executed machine. The steam cylinder is mounted on the top of a substantial cast iron frame, and the piston gives motion direct to the saw.* In this machine everything requisite to make it substantial was accomplished, and the traverse motions were well made and ingeniously contrived.

Endless saw.

The greatest novelty among the whole group, however, was the belt, or endless saw for cutting scrolls, squares, and circles of every possible curve. This instrument was so admirably contrived, that from its rapidity of motion, flexibility, and continuity, it accomplished in cutting almost every description of form, and its vagaries (if I may use the expression) were so eccentric as to require a steady hand to guide and a steady eye to trace its operations in the lines of the cut, and some of these are so fine and so curiously curved as to puzzle the conception of the casual, and sometimes even that of the practised observer. The machine itself consists of a thin flexible riband of steel, almost three-quarters of an inch wide, and about the thickness of the blade of a lance, or a thin visiting card. The extreme ends of this riband, about 18 to 20 feet long, are run through two narrow slits of a table, and having passed over pullies fixed at the top and bottom of the frame, it is brought into a state of tension by screws, and thus rendered fit for use by steam or any other motive power attached to the axle of the bottom pulley. The table on which is fixed the article to be cut has a sort of ball and socket motion, which enables the operator to cut at angles from the vertical to any degree of obliquity which the nature of the work requires. This simple, yet ingenious machine, has been purchased by Colonel Tulloch for the carriage department of the Royal Arsenal at Woolwich, and its applicability to the purposes of preparing timber of intricate forms, will, I make no doubt, prove equally beneficial in this as it is in ornamental cabinet work.

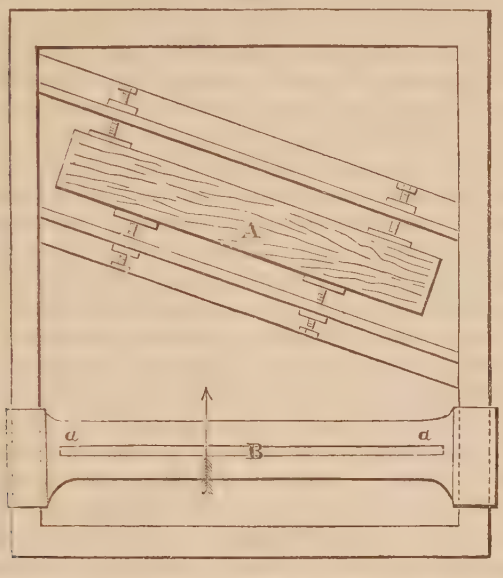
Veneering achine.

The next machine, although not new, is nevertheless of some importance for cutting veneers; this is effected on the principle of the common hand plane. It consists of a strong cast iron frame, on which slides another frame, to which the cutter is attached. This cutter is so constructed as to plane

* This description of saw is an adaptation of one patented by Mr. Sang, of Johnstone, near Paisley, and has been in use in this country for many years.

or cut off the veneer at an angle of about 20°. In Fig. 11, A is the timber, and B the frame which contains the

Fig. 11.



cutter. This frame moves in the direction of the arrow, shaving the timber in its passage to the required thickness of the veneer. The cutter or *plane iron* is placed at a certain angle with the horizon, in order to cut clean and deliver the veneer through the opening or slit *a a* in a perfectly sound and an unbroken state. To prevent injury to the fibres of the veneer by tearing, and to deliver it free from cracks or flaws, it is not only necessary to keep the cutter perfectly sharp, but to steam the block, in order to prevent the veneer from tearing during the progress of cutting, as it would in a dry state. Machines, almost identical, have been in use at Manchester and other places for years in cutting the sides and bottoms of hat and pill boxes. Some of these machines will cut slices or shavings the whole length and width of the block, from the finest riband to one-tenth or one-eighth of an inch in thickness.

Machine for bending ship timber.

In the American department the model of a machine was exhibited for bending timber for ships' knees, and every description of curved work employed in cabinetmaking, joinery, &c. This machine, according to the inventor, Mr. Blanshard, has been used successfully at New York, and the consideration has been, how far it is applicable to other purposes besides those of ship-building and cabinetmaking.

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Judging from the model and the full-sized specimens of ships' bows and stern posts exhibited, the machine must be one of great strength, and though the piece of oak, ash, or other description of timber to be bent must first be steamed, it is clear, that a piece of solid oak 12 inches square cannot be curved to a radius of four or five feet without the application of an instrument of great power. The apparatus having such work to perform, consists of an exceedingly strong frame, to which the timber to be bent is fixed. One end is forced against a stop by a screw or a wedge at the opposite end, and the back or convex side of the timber being covered by a flexible iron plate fixed at one end to the stop, the plate as well as the timber is then drawn round by a capstan and chain at the opposite end to the desired curve, which varies in force according to the shape of the block round which it is bent. From this description it will be seen, that the fibres of the timber on the convex side cannot be torn asunder, so long as the piece is not elongated, and the plate on the back being pressed with great force against the whole surface, effectually prevents the starting of the fibres during the operation of bending. The result of this process is to secure the convex side from fracture, and a crushing or sliding of the fibres into each other takes place on the concave side, which latter process is evident from the appearance of the crushed fibres and the new condition and form it is forced to attain.

From this it will be seen, that the forces employed are chiefly those of compression, and that the fibres are not seriously injured by tension. In order that the timber may retain its form, it is not removed from the frame until it is quite cold and has taken a permanent set.

The machine appeared to be one of great importance when applied to the preparation of timber for ship-building and other descriptions of curved work, extensively used in furniture and other works of utility and ornament. The inventor, Mr. Thomas Blanshard, of New York, has, I believe, applied the machine with great success to the bending of timber for plough handles, wheel felloes, and other purposes of utility.

Machinery used in Mining Operations.

In this section were comprised every description of engine tools, lifts, and parachutes, used in mining, and especially those affording greater security to the miner, and those for increasing the facilities and means of underground workings, including those for subterranean transit, and the raising of the mineral products at a cheap rate to the surface.

What this section embraces.

There are few subjects of greater importance to the community than that of the machinery of mines. So many of the comforts and enjoyments of civilized life depend upon the labours of the miner, that every discovery and every invention which tends to his advancement and security under the perils and hardships of his laborious life, must always be acceptable and justly entitled to reward. At the Paris Universal Exhibition, the machinery of mines and other devices for assisting in mining operations, were both numerous and instructive; and conceiving that a brief description of some of them may be useful, I shall endeavour to describe in detail a few of those which exhibited the greatest excellence and greatest ingenuity.

Importance of this branch of inquiry.

It will not be necessary to notice the larger machines and engines, such as those for pumping and winding; they are already so well known as not to require description here.

1. *Parachutes: An Apparatus for Preventing Accidents in Coal Pits.*—The ancient method of raising coals from the bottom of the pit to the surface was by a basket, suspended to the end of a rope wound round the barrel of a windlass, worked by hand or by the horizontal horse gin. Since the introduction of the steam-engine these primitive methods have given way to a better system, one of which is, by using one or more buckets or "corves," as they are called in the north, attached to each end of the ropes or chains, so that those at one end are descending whilst those at the other are ascending the pit. It not unfrequently happens that the ropes or chains which are used break, and the baskets or corves are precipitated to the bottom, and should any of the workmen be ascending or descending at the time, the result is attended with a serious loss of life. The present method of raising coal is a great improvement upon the old plan; it consists of four lines of iron rods, or, more frequently, wooden guides, which extend from the top to the bottom of the mine. Between these guides slides a wooden frame with two or more shelves, on which are placed boxes containing from eight to ten hundredweight of coal. These boxes are constructed to run upon tramways through the workings, where they are loaded and sent forward, either by horse or manual

Old plan of raising coal to the surface.

Present method.

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power, to the bottom of the shafts, and are then at once run on to the shelves of the sliding frame already described; in this position they are raised by the steam-engine to the top. They are then received by a moveable frame, with a corresponding tramway, which slides over the mouth of the pit, and from this again they are run forward to the screens, where they discharge their contents. It is evident that in our improved workings, great facilities are afforded for the raising of large quantities of coal in a short period of time; and in order to show with what despatch these operations are effected, I may refer to the colliery of Mr. Astley, at Dukinfield, near Manchester, probably one of the deepest mines in this country, where the coal is raised in four boxes, each weighing eight hundredweight, upon one rope, from a depth of upwards of 2,000 feet, at the rate of 20 miles an hour.

Parachutes.

To prevent accidents in mines of this description, parachutes were invented; they generally consist of two strong iron blades, which in their working state remain at a short distance from the vertical slides. They are attached to the top of the cage, and in the event of the rope breaking, these blades by the falling weight and the assistance of a spring press forcibly against the slides, and thus by the friction against the sides, stop the cradle and prevent its falling to the bottom.

One of the parachutes made by M. Fontaine, of Anzin, had, it is said, saved the lives of 37 persons, and in no instance has it ever been known to fail. In England, as well as on the Continent, this description of apparatus is in general use, particularly in deep mines.

Lift apparatus for raising material and men to the surface.

2. *Apparatus for Raising Coal and the Workmen from the Bottom of the Mine by the Pump Rods.*—This is not a new contrivance, as I believe it was first used in Cornwall, where the workmen to this day, in many of the copper and tin mines, continue to make their ascent and descent by ladders. M. Warocqué, of Belgium, however, exhibited a beautifully constructed working model of an apparatus to save this labour. It consisted of the shaft and pump rods, with a series of platforms attached to the pump rods at every ten feet in height, that being the length of the stroke of the pumps. The pump rods move alternately, one being at the bottom of its stroke when the other is at the top. The baskets containing the material are run on to a platform which is raised by a self-acting apparatus attached to the pump rod to a height of ten feet, the length of the stroke; they are then transferred to the next, ascending, pump rod, which again lifts them ten feet, and so on alternately.

The transfer, both in the ascent and descent, from the last to the next lift, was not only very ingeniously contrived but was effected with great precision. The raising or lowering of the workmen was effected by the same process, but with this difference, that they had to step from the ascending platform every time they arrived at the height of the stroke, and thus by a succession of lifts they arrived at the top. This very complicated process is greatly inferior to the plan of winding, which brings up the workmen and the coal at once from the bottom, saves all this complexity of motion, performs the work with five or six times the rapidity, and effects the whole operation with much greater certainty. This apparatus failed in Cornwall, and from every appearance it is not likely to succeed in either this country or in France.

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3. *Machinery for Washing Coal.*—I am not prepared to state to whom the public is indebted for this machine: I believe it is of English origin, and has been in use in this country for some years past with considerable success, at the Cleater Iron Works in Cumberland, where I have seen it at work; it is also used in France at the Decazeville mines. It consists of two rollers, which crush the coal to a proper size, when it is collected into a runner below, and from thence elevated to the washing apparatus above. This consists of several perforated plates, the first having holes about one inch in diameter, and the second about half that size. These plates receive an oscillating motion, and a stream of water being forced through the openings, a regular deposition takes place according to the densities of the different parts as they pass through the water in their purified state. Several of these machines are at work at Newcastle, Witham, Wales, and Wigan.

Machinery for washing coal.

4. *Boring Tools.*—It is difficult to determine whether the apparatus for boring to great depths used on the Continent is superior or inferior to the apparatus employed in this country. Several ingenious tools of this kind have been brought into notice, such as those which cut out the core from the centre of the base. The recent improvements of Mr. Mather, of Salford, appear to execute this difficult process with the desired effect.

Boring tools.

An apparatus constructed by Mr. Degoriue was exhibited at the Exhibition, and is calculated to bore from 200 to 2,000 feet. It consists of a small oscillating steam-engine, which works a windlass, and moves the boring rods by a cam for pounding hard homogeneous rocks; and it is also calculated to work at various speeds, according to the depths and density of the strata into which it penetrates. The tools them-

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selves were exceedingly well made, of almost every possible variety of form; those used for deep boring, for catching and recovering broken rods, &c., deserved great praise for the skill and the ingenuity displayed by the maker.

Superiority of English mining operations over those of other countries.

It would be necessary, before venturing to express an undivided opinion as to the merits of the mining operations of France, Belgium, &c., as compared with those in which this country is engaged, to make the tour of Europe, and examine personally into the different methods by which these objects are attained. Judging, however, from the different machines and apparatus contributed for exhibition, I am of opinion, that there is probably no country where the operations of the miner are carried to the same extent or the same perfection as in Great Britain. Here we have mines of greater depth and of greater extent than in most other countries, and we have probably greater experience, arising from the abundance of fuel, and the advantages of steam power always at command.

Machines used in Agriculture, &c.

Reaping Machines.

Machines of this kind are of great antiquity; they were known to the Romans, and a graphic description is given of them and their uses by Pliny. Those of modern date have many properties which bear more or less directly upon those of antiquity; but we hear nothing of them during the dark and middle ages, and from these remote times up to the present we have few traces of improvement or successful attempts to substitute machine reaping for the sickle. Various machines were invented in the early part of the present century, though the probably first successful attempt was made by Mr. Smith of Deanston in 1812. This machine was followed by those of Ogle in 1822, Mann in 1832, and Bell of Carmyllie, Forfar, in 1826. Mr. Bell has used his machine and gathered in his harvest by it for the last 29 years; and it is not too much to say that most of those now in use, both in this country and America, are based upon the principle which he introduced. There is a great similarity in all these machines, and those shown at the Universal Exhibition of Paris exhibited nearly the same characteristics in principle and construction as those at the Exhibition of 1851. M'Cormick, Croskill, and others introduced some slight improvements, but the principle of the machine remains unaltered, excepting the receiving boards, which in those brought forward for competition at the Paris Exhibition are exceedingly variable in form and construction, and some of them very ingenious. The period of the Universal Exhibition was most favourable for giving a fair trial to machines of this description, and the month of August afforded an excellent opportunity for testing their merits by actual experiment. Through the liberality of M. Dailly, a distinguished agriculturist and member of the Jury, a field of oats on his farm at Trappes, was set apart for the exclusive purpose of ascertaining the properties and proving the value of these machines. On the 2nd August at 11 o'clock, the machines were divided into three groups, and the contest for superiority commenced as follows:—

Great antiquity of these machines.

Modern machines.

Experiments with the machines exhibited at Paris.

		Mètres.
Group 1st	Mr. Cournier's allotment - -	1,628
	Mr. Wright's „ - -	1,733
	Mr. Laurent's „ - -	1,825
Group 2d	Mr. Mazier's „ - -	1,826
	Mr. Manny's „ - -	1,900
	Mr. Croskill's „ - -	1,958
Group 3d	Mr. M'Cormick's „ - -	1,987
	Mr. Dray's „ - -	2,250
	— Canadian „ - -	1,650

Division of the machines into groups.

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The points to be ascertained, in order to judge of the merits of the machines, were, as far as I could learn, the time required to cut the allotment, the number of hands employed, and the perfection by which the work was executed without injury to the grain. The first group commenced operations by beat of drum at 11 o'clock, all three starting at the same time.*

the first group; Cournier's machine.

Group 1st: Cournier's Machine (French) *on Bell's Principle.*—This machine (with one horse) cuts clean, but the cutters are liable to get entangled with straw, and a great deal of time was lost from this cause. This defect appears to be common to all the machines when the speed happens to be reduced under two and a half miles an hour. In this respect I found the maximum velocity of the machines to be as nearly as possible three miles an hour, and the knives for every 18 feet in distance, that is, for one revolution of the wheel, made 11 single or 22 double cuts. This machine had a sliding rake motion, to enable the reaper to clear the receiving board of the grain as it was cut. It might be improved and made more effective, and would work much better with two horses and a wider cutting board, so as to take a greater width of grain and maintain the speed necessary to a maximum velocity and a maximum result. From the frequent clogging of the cutters, it required 67 minutes to cut 1,628 square metres of corn. In this machine the reel for gathering the corn went too fast, and injured its working by striking the grain too high up the stalk.

Wright's machine.

J. S. Wright's Automaton Machine (American) executed 1,733 square metres in 24 minutes. This machine is nearly self-acting, requiring only a driver and one attendant to follow the machine in case anything goes wrong. Its novelty consists in a rake worked from the wheel that drives the cutter shaft; it is attached by an arm or connecting rod to the bevel wheel, and by a combination of levers receives a rotatory motion, which, along with that in a longitudinal direction, drags the grain forward over the edge of the board; in order, however, to make sure of the discharge, another rake or cleaner strips the before-mentioned one of its load, and lays the straw in parallel lines, ready to be bound into sheaves. This machine, like Cournier's has some clever devices, but requires further alterations and contrivances to simplify and make it more effective and complete.

* The Imperial Government, ever alive to the interests of the community, and the advancement of the useful arts, took a deep interest in the trials; and in order that the Jury might not be incommoded, the Prince Napoleon sent forward some mounted gens d'armes and a few soldiers of the Line to maintain order and keep back the crowd.

Laurent (French).—This machine, like Cournier's was constantly choking with the straw round the cutters. It is a copy of Bell's, and requires two men at the pole, a driver, and a reaper to work it. It is a heavy machine, and almost too much for two horses to work. The falling off in the speed was the reason of its entanglement. In all these machines speed is an element of success, as whenever the velocity of the knives and the speed of the machine was reduced, choking and entanglement of the straw resulted. Under these circumstances it is therefore a consideration of much importance to have these machines of such dimensions as to enable the horses to work them with ease at the required velocity.

Laurent's machine.

Group 2d: Mazier's Machine (French).—This machine is of light construction, adapted for one horse, and cuts a breadth of 2 feet 7 inches in a line all round the field. It cuts either right or left, by means of the frame containing the cutters turning on a central axis. The knives are worked by a wheel and worm, and are well calculated to cut light grain, such as oats and barley, but might prove inoperative on a field of heavy wheat. The machine as a whole was rather slender for the work it had to perform; but if well constructed, and the parts judiciously proportioned for two horses, there is no reason why it should not reap any description of grain. In the attempt to cut the allotment, it unfortunately broke down, some of the parts giving way.

Trial of the second group; Mazier's machine.

J. H. Manny (United States).—Mr. Manny's allotment consisted of 1,900 square metres, which was cut in 26 minutes. The machine is worked by 2 horses and cuts a breadth of 4 feet 6 inches. Mr. Manny speaks highly of his machine, and gives numerous testimonials of its efficiency, exclusive of medals, premiums, and awards from different districts in America and from different countries in Europe for its performance. According to Mr Manny's account, "it will *cut either grass or corn when down, wet or dry*, and in whatever direction the wind blows, without being stopped for a single instant." Mr. Manny further observes, "that it can in a few seconds be converted from a reaper into a mower, as the only thing required is to withdraw the platform, and change the scythe of the reaper for the cutting scythe of the mower."

Manny's machine.

"The cutting apparatus for corn or for grass is made in such a way, that it cuts as well backwards as forwards. When the machine is reaping, the wheat is received on the platform, gathered, and put into a heap by the action of a wind board, and by a single stroke of his rake the attendant puts down on the ground, at the back of the machine, the already made sheaves, which only require tying."

It will not be necessary to follow Mr. Manny in his de-

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scription, which evinces great confidence in the superior performance of the machine; suffice it to observe, that it did its work moderately well, though some parts were not clean cut.

Croskill's machine.

Croskill's Machine (English) is an improvement upon Bell's, and in great repute amongst the farmers of the North Riding of Yorkshire and other parts of England. In the hands of Croskill it has received several improvements, but unfortunately on this occasion the key of the connecting rod that works the knives got loose, dropped out, and stopped the process of reaping; under these circumstances it was considered advisable to withdraw the machine, and leave the field open to the other competitors.

Trial of the third group; M'Cormick's machine.

Group 3d: M'Cormick's Machine (American). — This reaper is probably one of the best machines of its class. It reaped 1,987 square metres in 17 minutes; and judging not only from the quantity of work done in so short a time, but from the manner in which the ground was cleared, and the grain cut, it evidenced much greater perfection in its operations than any of the others whose powers were brought to the test.

It cuts a clean track of 5 feet 6 inches wide, and performs the operation with a degree of certainty and precision sufficient to account for the very short time in which the allotment was cut down. This machine, like most others, is susceptible of still further improvements; and I am glad to find that Messrs. Burgess and Keys (the makers) are about to introduce a new moveable apparatus, consisting of Archimedean screws, for delivering the grain from off the receiving board, as it is cut. This would render the machine much more perfect, as the great defect of this machine was the way in which the grain was delivered from the platform after being cut, and the evident want of some method of laying the heads and straw parallel and in bundles or sheaves; and also for clearing the track for the horses on the return cut. Burgess and Keys' clearing apparatus, if properly constructed, may probably remedy this evil, which is the principal objection to the use of this machine.*

Drays' machine.

W. M. Dray and Co.'s Machine (English) is of an exceedingly compact form: it is entirely without a reel for gathering in the corn to the cutters, and requires only one man as a reaper to watch the cutters, and discharge the corn as it is received upon the board or wooden platform behind. The cutters are 5 feet wide, and it reaped 2,250 square metres in

* A trial has been made of this apparatus since the above was written, but without success. I am not prepared to state from what cause, but will take an early opportunity of ascertaining the facts, or of witnessing its performance.

35 minutes.* The peculiar features of this machine are its portable construction, and the receiving board, which moves upon an axis; and by the pressure of the reaper's foot the platform is tilted, and the grain drops behind, ready for the person who follows to bind and tie it up.

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The only objection to this process is, that it requires the binding to be done immediately; otherwise the working of the machine would be impeded, and the horses at every succeeding cut would trample over that previously reaped. Under these circumstances the track previously cut must be entirely cleared, in order to prepare for that which succeeds. This appears to be the chief defect in the machine. A different clearing apparatus to effect the discharge of the cut grain in a lateral direction would render the machine much more valuable. It would give time for binding up the grain into sheaves, and at the same time it would clear the track for the horses and machine in their return for the next cut.

The last machine (Canadian), which completed the three groups, was withdrawn from some cause that was not explained.

Canadian machine.

The following Table, which Mr. Edw. Combes has kindly handed to me, gives the results of the different trials as follows:

TRIAL of REAPING MACHINES, on the Farm of Mr. Dailly, at Trappe, near Paris, 2d August, 1855.

No.	Maker's Name.	Country.	Breadth of Cutting Part.	No. of Square Metres cut.	Time.	No. of Horses.	Price.	Remarks.
1	Cournier	France	4ft. 3in.	1,628	67	1	£26	Driving wheel 3′ 3″; crank makes 11 revolutions to one of the wheel; knife not serrated.
2	J. S. Wright	U.S. America	5 3	1,733	24	2	36	Diameter of driving wheel 4′ 4″; crank makes 24 to 1.
3	Laurent -	France	5 0	1,825	66	2	—	Diameter of driving wheel 3 feet; crank makes 15 to 1 (similar to Bell's).
4	Mazier -	France	2 7	Broke down -		1	—	Small machine, cutting either right or left by means of the cutter frame turning on a central axis; knives worked by wheel and worm.
5	Manny -	U.S. America	4 6	1,900	26	2	26	Diameter of driving wheel 2′ 6″; crank makes 13 to 1.
6	Croskill (Bell's.)	England	5 0	Broke down -		2	45	
7	M'Cormick	U.S. America.	5 6	1,987	17	2	30	The particulars of these are well known.
8	Dray -	England	5 0	2,250	35	2	25	
9	The Canadian machine		6 6	Retired		2	—	

* Some say 34 minutes.

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Great defect of all the machines was the small size of the gear.

On a careful examination of the several machines entered for the prizes, it should be observed that in every one of them an attempt was made to effect a certain purpose by means of transmission, calculated to retard rather than facilitate the process of cutting. It is true that in machines of this description, where horses are employed as a motive power, it is desirable to make the parts as light as possible, and to effect the motion of cutting, reaping, &c., with as light wheels and motions as can be made. But these small wheels and their attachments, as applied to these machines, appear to me to be the very worst and heaviest parts of the machine, and I would earnestly urge upon the makers of reaping machines the absolute necessity of increasing the diameter and dimensions of the gearing which works the cutters, and at the same time to attach the journals and ends of the shaft into *one casting*, so that they cannot vary in position, but must move, and, speaking technically, go and come with the machine. These alterations being made, and proper clearing apparatus attached to the receiving boards, we might expect these machines to perform the labours of the harvest with much greater certainty and effect than is at present accomplished.

Order in which the machines stood in regard to time.

From the above Table it will be seen that M'Cormick's American machine performed the most work in the least time; that Wright's and Manny's executed as nearly as possible the same quantity of work in the same time, there being a fraction in favour of Manny, and that Dray was the next in the order of time and the quantity of work done.

Reducing the whole work done to a standard of 2,000 square metres, the competing machines will stand thus:—

	Mètres.		Minutes.	
M'Cormick's would cut	2,000	in	17·11	
Manny „	2,000	„	27·36	Mean,
Wright „	2,000	„	27·69	25·81.
Dray „	2,000	„	31·11	

The above Table shows the order in which the competitors stood in regard to time.

Necessity of doing away with the present system of ridges, in order to secure success to machines.

In the investigation of this subject we have hitherto confined our observations to the machines. There is, however, another element equally important and essential to the efficiency of the process of machine reaping, and that is the *preparation of the land;* and, in fact, before we can look forward to complete success, the surface must be levelled, and the present injurious system of ridges dispensed with. To apply machinery to the labours of a farm, the land must be prepared not for hand but machine culture, and the successful introduction of reaping machines will chiefly depend

upon the preparations that are made for their reception. The system of ridges may be tolerated and overcome with the sickle, but to give to the new process of reaping by machinery its full effect, a totally different plan of operations must be pursued, and the fields laid down with *a perfectly smooth surface*. The larger description of stones and other obstructions should be removed, and in place of the superfluous waters not required for the nourishment of plants being allowed to flow between the ridges on the surface of the field, sweeping, in heavy showers, everything before them, the new system of drainage will require to be adopted, and the water carried *under* in place of running *over* the surface.

Agriculturist's duty must be performed as well as engineer's.

To make a machine, such as a reaping machine, work well, everything must not be left to it; the agriculturist must do his duty as well as the engineer; and the duty duly performed *on both sides*, will secure certainty of action, solve the great problem of machine labour, and effect satisfactory results. When this is accomplished we may then, *and not till then*, reasonably look forward to the crops being well and quickly gathered by machinery, to the exclusion of a laborious process effected with difficulty, and often imperfectly executed, by the human hand. One of the great advantages of machine over that of manual labour is the great saving of time effected by the machine, and this alone is of vast importance in countries like England, where the climate is precarious, and where a whole harvest may be lost or seriously damaged by a wet season, unless rapidly cut and housed. At such times the *machine reaper becomes invaluable*, and cannot fail, when properly constructed and properly applied, to prove a great national benefit.

Thrashing Machines.

The thrashing machine an exception to the rule of reciprocal duty.

When discussing the comparative merits of the reaping machines, and tracing the improvements that have been effected and are still in progress in the machinery of agriculture, we had occasion to advert to the circumstance that no machine of this description (however perfect its construction) could ever become generally useful unless the land was prepared by a special process of culture for its reception. The same reasoning does not, however, apply to the thrashing machine, which is stationary in its operations, is well understood, and has undergone little or no improvement (excepting only in form of construction) since the days of its inventor, Mr. Andrew Mickle. The portability of some and the stationary characters of others render their applicability more certain than heretofore, and although a large and

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well conducted farm is seldom or ever found without a steam engine and a thrashing machine, there are nevertheless a great number of small farmers who are without them. To provide for these, portable thrashing machines were contrived.

Steam machines and horse machines.

The thrashing machines of the Universal Exhibition were of two kinds, those driven by steam and those by horses; nearly the whole of them were portable. The advantages of this construction are the convenience of transporting them from place to place, and for giving to the small farmer the same benefits of thrashing and winnowing by machinery as are enjoyed by the large farmer with his fixed engine.

Experiments on the steam machines.

One of these machines, with a small engine (which serves a whole district), will thrash, winnow, and clean a stack of wheat or barley in a comparatively short period of time. Most of the machines of this description exhibited at the Exposition were experimented upon, first at the Conservatoire des Arts et Métiers, and lastly at the agricultural sheds between the Palais de l'Industrie and the Annexe. At the Conservatoire des Arts the trials were made under the direction of M. Tresca, Sub-Directing Engineer of the Conservatoire, with a portable steam-engine by Tuxford, of the nominal power of six horses. M. Tresca had by various experiments ascertained the quantity of steam that would pass through the throttle valve at each degree of opening (which he had graduated); then by knowing the quantity of steam used, the pressure, and the number of revolutions made, he found the power expended by the engine.

There was no pressure indicator to the cylinder, but the pressure in the boiler was kept constant at five atmospheres, or 75 lbs. on the square inch.

Nos.	Maker's Name.	Country.	Total Number of Fly-wheel Revolutions.	Weight of Sheaves in Kilogrammes.	Time in Minutes.	No. of Revolutions made by the Drum.	Diameter of Drum in Inches.	Power expended in H. P. French Calculation.	Remarks.
1	J. A. Pitts	Buffalo, U S.	2,800	951·75	20'15"	24,192	16in.	7·45	Broke the grain and straw. The drum carried teeth, which worked between others fixed.
2	Paige & Co.	Canada	1,020	380·70	10 20	9,588	16	7·45	Pretty good work; this drum was also made with teeth.
3	Cumming	France	1,504	285·50	11 0	5,910	30	6·50	Good work.
4	Garrett -	England	1,608	378·90	13 45	11,899	22	8·52	Ditto.
5	Hornsby -	Ditto	1,315	378·90	9 25	9,468	21	10·52	Very good work.
6	Clayton & Co.	Ditto	955	364·00	6 39	6,446	20	—	Cleaned the straw well, and did not break the grain.

The numbers in the eighth column, giving the quantity of power expended by each machine, were given me by one of the Conservatoire engineers, who superintended the throttle-valve. Correct results of the experiments of pressure could not be obtained with certainty, and cannot therefore be depended upon.

Order in which the machines stood in regard to quantity thrashed.

Reducing the foregoing Table to the rate or quantity that each machine would thrash in an hour, and assuming that in all of them the straw was equally well cleaned, and without injury to the grain, the makers would stand in the following order:—

	Kilogrammes.	
Clayton, Shuttleworth, and Co., England, would thrash in one hour	3,284	
J. A. Pitts, Buffalo, „	2,820	
Hornsby, England, „	2,415	Mean, 2,323
Paige and Co., Canada, „	2,211	
Garrett, England, „	1,653	
Cumming, France, „	1,557	

The average or mean of the whole is therefore 2,323 kilogrammes per hour, and the difference between the performance of the first and last machine would be 1,727 kilogrammes per hour. On a careful examination of the work done by each machine, it was found that Clayton and Shuttleworth's not only thrashed out the greatest quantity in the same time, but the work was well done, and the straw properly cleared without breaking the grain.

Experiments on the horse machines.

The next class of machines were those worked by horses, of almost every possible variety of construction. Some were made to fix with a frame imbedded in the ground with stakes, and a start or pole extending to the extremity of the horse walk. This pole was generally fixed to the back of a crown or bevel wheel, which gave motion to an underground shaft for driving the machine; others dispensed with the shaft, and by a pair of spur-wheels gave motion to a vertical shaft and pulley, which drove the machine by a strap overhead. All these machines some of them well contrived, had two faults; first, the limited radius of the horse-walk, and, secondly, the small diameter of the wheels for attaining the required velocity and for driving the drum. More than one-half of the power was lost from these defects, exclusive of the difficulty and severe labour the horse had to undergo in travelling round a small circle. In fact, there could not be a worse application; and I hope the millwrights will in their calculations take these objects into account, and endeavour, by enlarging the diameter of the horse-walk, to bring the line of traction in a more direct line.

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It will not be necessary to give an account of all the experiments made on the different machines; suffice it to observe, that those which indicated the best results are given in the following Table:—

THRASHING MACHINES WORKED BY HORSES.

Thrashing Machine Trials, 21st August 1855.

No.	Maker's name.	Country.	Weight of Straw.	Time taken.	Diameter of Horse Walk.	Diameter of Horse Wheel.	Dia. of Drum.	Remarks.
			Kil.	Min.	Ft.	Ft. in.	In	
1	J. Pinet, Jun.	Abilly, France.	285	8	20	4 1	19½	Made very good work of both straw and grain; machine driven by an overhead strap; drum is open; horses not worked very hard.
2	Lotz, Sen.	Nantes, ditto.	279	12	28	3 10	19	The horse-works and thrashing part are made together, the horse-wheel being on the top of the machine. The pinions in this machine are all very small. Horses worked very hard.
3	Jasquet Roux.	Issoudan, ditto.	291	19	13¾	3 10	25½	Bolting the straw, leaving it in a very good state. Made pretty good work, but seemed very liable to derangement. Driven by an overhead shaft. Drum and blower driven by straps. Drum spindle runs one side on antifriction rollers; the other is placed on the short arm of a lever, kept down by a spring. Horses worked very hard.
4	Renaud & Lotz.	Nantes, ditto.	269·7	14	16	2 0	17	Machine driven by an overhead shaft; very small pinions. Hard work. Broke the straw.
5	Terrolle -	,, ,,	277·5	15	21	2 6	18	Has its horse-works enclosed; made pretty good work, but very hard for the horses.
6	Arthuis -	Château Gortier, France.	- -	- -	21	2 5	20½	The horse-wheel has nothing to keep it in gear; consequently the teeth kept slipping; the trial could not be continued.
7	E. Kämmerer.	Bromberg, Prussia.	Broke	down	24	6 0	19½	Copy of a machine exhibited at the York show, 1848, by Rawlings. Drum makes 298 revolutions to 1 of the wheel.
8	Drewitz & Rudolf.	Thorn, ditto.	283·3	16	20	2 6	16	Thos. Barratt and Exell's "concave" adjustments. The drum is driven by the friction of its pulley against the internal part of a fly-wheel, makes 248 revolutions to 1.

No.	Maker's name.	Country.	Weight of Straw.	Time taken.	Diameter of Horse Walk.	Diameter of Horse Wheel.	Dia. of Drum.	Remarks.
			Kil.	Min.	Ft.	Ft. in.	In.	
9	Arthuis.	Château Gortier, France.	253	15	21	5	20½	This was tried on the 21st, but failed; however, they managed to make it work a quarter of an hour to-day. Drum makes 250 revolutions to 1.
10	Steimmig.	Dantzic, Prussia.	282	15	22	5 8	18	A complete copy of Ransom's old horse works, with Cambridge's machine 344 revolutions to 1, made pretty good work.
11	A. Logendre.	St. Jean d'Angely, France.	154	15	19	2 10	18	Much too small "feeding box," causing a drag on the straw, consequently cutting it into chaff; made 313 revolutions to 1.

Reducing, as before, the experiments in the above Table to the quantity of work done in one hour respectively by each machine, the results will be:

Order in which the machines stood as to quantity thrashed.

	Kilogrammes.	
J. Pinet, France	2,137	
Lotz, jun., do.	1,395	
Renaud and Lotz, do.	1,155	
Steimmig, Dantzic, Prussia	1,128	
Terrolle, France	1,110	Mean, 1170·3
Drewitz and Rudolf, Prussia	1,062	
Arthuis, France	1,012	
Jasquet Roux, do.	918	
A. Logendre, do.	616	

In the above average of work done, it will be seen that a wide difference exists between J. Pinet and the two last makers, Jasquet and Logendre, the first being nearly double the average, and the other two being below that point by as much as 252 and 554 kilogrammes respectively, the latter being only half the average. The others are remarkably near, and, perform almost the same duty, excepting Lotz junior, who exceeds the average 226 kilogrammes.

Beneficial effect of the report on these machines.

Some of the horse machines were of iron, but the most of them of wood. In the report of the Jury the experiments will be brought forward more in detail, and considering the great care bestowed upon the investigation by Mr. Moll, the reporter, and General Piobert, we may reasonably conclude that the promulgation of the report in the rural districts of France will have the effect of stimulating those that are

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behind to a friendly rivalry in the attainment of improvements calculated to advance the interests of the public, and to compete with M. Pinet, who stands prominently forward at the head of the list.

Machines for making Bricks and Tiles.

Great demand for this description of manufacture of late years.

These machines are extensively used in agriculture; and of late years great attention has been bestowed upon their construction. The great demand for draining tiles and hollow bricks has given a new impetus to this description of manufacture, and the machinery by which they are produced has undergone an entire revolution during the last few years.

Machines exhibited at Paris.

At the Paris Exhibition a great variety of clever contrivances were observable, and the manufacture of tubular bricks and tubular tiles of almost every form were exhibited.

Typographical Machines.

General importance of this branch of art.

The mechanism of printing or typography has of late years been held in high estimation, and the rapidity, exactitude, and facilities which that department of mechanical industry now exhibits are, amongst many other improvements, the wonder and luxury of the age in which we live. The art of printing involves other considerations besides those of mechanical construction: it embraces the art of despatch in production, and effects the wide and rapid diffusion of knowledge. And it is no small boast that upwards of 50,000 copies of a daily paper like "The Times" can be composed, printed, and distributed to the remotest part of the United Kingdom within a period of less than 18 hours. Such, in fact, is the progress of mechanical typography; and the different machines and printing presses contributed to the Universal Exhibition were no small indication of the progress made in the art of printing in France, in this country, and in other parts of Europe.

Typography is an art of such vast importance to the community, that it cannot fail to interest the observer and advocate of intellectual progress; and every improvement which tends to increase the facilities for rapid production in this art must always be acceptable to the politician and philosopher.

Able assistance of M. Holm.

With these impressions the Jury entered upon the investigation of the numerous machines contributed by different makers to the Universal Exhibition. In this inquiry, the Jury were ably assisted by M. Holm, the representative of Sweden and Norway in this mechanical department, and to the discrimination and sound judgment of that gentleman the Jury are indebted for an able investigation of the merits of most of these machines.

M. Holm was the reporter to this Division in Class VI., and has exercised a sound discretion and great care in his inquiries into the peculiar properties and novelties of each machine; and having accompanied him in his investigations, I am the better able to judge of the value of each machine taken separately, and the rewards to which they are respectively entitled. It is, therefore, with pleasure that I have to record in this report, the peculiar features of these machines, as they came respectively under the notice of the Jury.

M. Dutartre's compound machine.

Vignette press.

The first was a double or compound machine, exhibited by M. Dutartre, of Paris, (No. 1395 in the Catalogue,) consisting of typographical press for printing "vignettes" and a machine for printing two colours on the same sheet. The typographical machine is remarkable for the solidity of its

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construction, and the great attention paid to the working out of the details. In the motion of the tables several improvements have been effected; the oblique action of the connecting rod being neutralized by an ingenious application of the guides, which effects a smooth and perfectly horizontal motion. This movement is obtained by a crank motion in connexion with a forked end connecting rod, and by means of a toothed wheel, a motion at once alternate and rotatory is produced. This wheel, acting by an ingenious contrivance upon the upper and under side of a rack attached to the impression table, produces an extended reciprocating motion, four times that of the radius of the crank. The inking process is also well contrived, and a novel arrangement was observed in the roller and ink-box, to which M. Dutartre has added a supplementary roller. This is worked by a toothed wheel, and not only acts as an agitator in producing the necessary fluidity and mixture of the ink, but regulates the necessary supply, with the proper quantity and thickness of ink for vignettes. This process obviates the necessity of warming the ink to maintain its fluidity. The inking rollers are worked by wheels instead of bands as formerly used, which ensures absolute certainty of motion, and maintains perfect uniformity and fluidity in the ink boxes. At the end of the machine is a table formed to receive the sheets as they are printed, and to clear the impression cylinder.

Two-colour printing machine.

The two-colour printing machine has nearly the same motions as the vignette press. It has a table of sufficient area to take in two frames at once, and two other tables (one at each end) for the retention and distribution of the two colours. Two inking boxes are also attached to each end of the machine, and the impression cylinder is proportioned in its circumference to the length of the table. The movements of this machine are so adjusted as to give two revolutions to the cylinder for one strike of the table; and the sheet is retained in the frame until two revolutions of the cylinder are accomplished, when it stops to receive another sheet. This contrivance appears very well adapted for certain kinds of work. Looking at the mechanical arrangements of the two machines and considering the objects to be attained in the printing of vignettes and two colours by one and the same process, the Jury were of opinion that the silver medal should be awarded to M. Dutartre for the utility as well as the novelty of these constructions.

Steam-press of Messrs. Marinoni.

Second.—Messrs. Marinoni, Chevalier, et Bourlier, of Paris, exhibited a steam press, (1,403 in the Catalogue,) of four cylinders for printing newspapers, and a single cylinder press for other purposes. On examination the newspaper press appeared to be well constructed, and is calculated to print 6,000 sheets

on both sides per hour. It is rather complicated, but with proper attention to the arrangement of the parts, it may be much simplified in its movements, and rendered a still more effective machine. It prints on both sides at once, but the sheets have to be cut in two, and on that account require four men to work the machine.

Machine for prints.

Messrs. Marinoni, Cheviller, et Bourier exhibited another machine for prints, similar to that of Dutartre as respects the movement of the impression table, but with this difference, that the table is supported on four rollers, which constitute the reciprocating movement of the press. This mode of moving the table is to some extent defective, as the only guides to the reciprocating movement in the table are the ends of the rollers, which are liable to wear, and entail variation and uncertainty in a part of the machine which requires great accuracy in its movements. In other respects it is well executed, and is in high estimation among printers, who prefer it to most others. Taking all these circumstances into account, the Jury were of opinion, that it was justly entitled to the Silver Medal.

Continuous machine of M. Nicholais.

Third.—M. Nicholais, of Paris, (No. 1,408 in the Catalogue,) exhibited a continuous machine, with a cylinder calculated to cover a large surface, and approach as nearly as possible to a plane. The peculiarity of this machine is, that the cylinder works by a fixed rack (on the principle of Baker's mangle,) attached to the table, and it is so constructed that it works only during the time it is in contact with the sheet, the period of rest being effected by the removal of a few teeth in the mortice wheel, which produces the stoppage without retarding the progress of the other parts of the machine. In this way the table is reversed in and out of gear, and in such form as to suit the impression, but not to stop the continuous movement and onward progress of the machine.

The machine, although containing nothing new, is well constructed, and considering the objects for which it is intended, and the facility with which it works, the Jury have awarded to M. Nicholais the Bronze Medal.

Three-cylinder machine of M. Normand.

Fourth.—M. Normand, of Paris, (1,409 in the Catalogue,) exhibited a three-cylinder machine for newspapers, and a press. The machine for printing newspapers indicates an important improvement of recent date, by which rollers in combination with other rollers, that revolve by a peculiar movement, effect the printing on both sides of the sheet. All these movements are on fixed bearings, which renders the machine more effective in its operations and much simpler in its construction. The motion of the impression cylinders is obtained from a rack on each side of the printing table; and the table is also moved by a rack and pinion fixed upon an "articulating" axis. M. Normand claims the invention of this

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peculiar motion of returning the sheet upon one and the same cylinder, which he patented in the year 1848, but having neglected to fulfil the requisite forms required by law, the patent has become null and void, and is now the property of the public. Disregarding, however, the question of priority of invention and patent rights, the organic parts of the machine appear to be well constructed, and in perfect accordance with the operations required to be performed.

M. Normand's press.

In the press, M. Normand has also introduced several improvements in the arrangement and adjustment of the pincers which hold the paper to the cylinder when working, and giving to it the requisite position in the press. Taking all these movements and adjustments into account, as also the perfect execution of the machines as pieces of merchandise, the Jury awarded to M. Normand the Silver Medal.

Vignette machine of M. Alauzet.

Fifth.—M. Alauzet, of Paris, (No. 1,387 in the Catalogue,) exhibited a machine for printing vignettes. It is well constructed, the parts being carefully developed; and it is remarkable for its solidity and superior workmanship. The table movement is effected by the ordinary rack motion, excepting that the teeth are of hardened steel. The impression table is furnished with two distinct sets of apparatus, with four rollers to each set for spreading the colour, and the table, rollers, &c. are of large dimensions, which gives solidity and greater exactitude to the performance of the machine.

Visit of the Jury to M. Alauzet's establishment.

M. Alauzet, finding it impossible to exhibit more than one machine, invited the Jury to visit his establishment, and to judge for themselves as to the merits and advantages peculiar to this construction. In that establishment the Jury found several ingenious movements and devices for simplifying and facilitating the process of printing, and amongst them a contrivance for giving the requisite pressure to the cylinder by means of eccentric curves placed above the axis of the impression cylinder. A brush is also attached to keep the paper to the cylinder, and in order to ensure uniformity in the impression, hollow bronze rollers are used in some cases above the other rollers, to equalize and distribute the ink.

Taking all these improvements into consideration, and the very perfect manner in which the machines did their work, the Jury unanimously voted M. Alauzet the Silver Medal.

Lithographical Machines.

Steam lithographic machine of Messrs. Huguet et Vaté.

Messrs. Huguet et Vaté, of Paris, exhibited a machine (No. 1,400 in Catalogue) which greatly resembles the typographical press. It is worked by steam, and consists of a table, upon which the stone is placed, and the impression is obtained by means of a cylinder with regulated stops, moved by racks, and worked by pinions, having an articulated axis

attached to the impression table. The platform or surface for the distribution of the ink is fitted to the impression table, and the machine taken altogether is nearly the same as the ordinary printing machine, but with this difference, that there is just sufficient space between the circumference of the cylinder and the impression table to admit the stone. When the stones are of different thicknesses, the required height is obtained by zinc plates; and to obviate any defects or unevenness of the surface of the stone, a thin piece of felt is interposed between it and the impression table.

In working lithographic presses by hand, it will be observed that the workman has to moisten the stone with a water sponge after the impression and before the ink is applied. This operation is effected by Messrs. Huguet and Vaté by damping rollers, covered with cloth saturated with water. The motion of these rollers is very ingeniously contrived, and immediately after the impression is taken the rollers are raised by curved eccentrics, and the motion is so well timed as to prevent them touching the stone after it is inked. This application of the damping rollers constitutes the novelty and superior efficiency of the machine; and such is the facility by which the impressions are taken, that 5,000 copies can be produced per day, while only one-fifth of that number can be executed by the hand-press in the same time. Considering the importance of this application, the economy of labour, and the increased rate of production, the Silver Medal was awarded to Messrs. Huguet and Vaté.

Presses of Messrs. Dupont, Daret, and Carlier.

Messrs. Dupont, Daret, and Carlier, of Paris, were large contributors in typographic as well as in lithographic presses. The former (three in number) are of great importance; and the fourth, although not equal to Messrs. Huguet and Vaté's machines, has nevertheless some points about it entitled to consideration. This machine may be used as a compound press, one-half worked by steam and the other half by hand. Like other presses of the same kind, the stone is placed upon a table, and the impression is taken by a cylinder rolling over its surface. The table is moved by a rack and pinion, but the stopping and starting is effected by hand; and the process of inking, fixing the sheet, &c., takes place during the time the press is at rest. From this it will be seen that a great deal of valuable time is lost by this process; and although some attempts have been made to remedy these defects by steam rollers at each end for distributing the ink, the machine is nevertheless far from perfect. Taking, however, into account the number of machines and presses exhibited, and the manner in which the work is performed, a Bronze Medal was awarded.

Portable press of

Among other articles of the lithographic art was a small portable press by M. Ragueneau, of Paris, (No. 1,152 in

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M. Ragueneau.

Catalogue,) which reproduces any kind of writing or drawing without transcribing the original on stone. This was done by simply writing the original, or what is wanted to be reproduced, on autograph paper with ink; it is then transferred to a metallic plate composed of pewter, antimony, and bismuth, fixed in a frame of the required size of the plate. The plate is inked by a roller in the same way as the lithographic stone, and a small tympan, or frame covered with leather, is attached to the block, and serves to cover the paper attached to the plate. The impression is taken by a small lever, which works the press by forcing the leather of the tympan upon the plate. The whole apparatus, with its inking rollers, &c., is contained in a small box, the price varying, according to size, from 50 to 150 francs. The facility with which writings can be reproduced by these means, the arrangement of the parts, and the compact form of the machine, were considered to entitle M. Ragueneau to a Medal of Bronze.

M. Schnautz samples and rollers.

The articles contributed by M. Schnautz (No. 1,412 in Catalogue) consisted of divers samples of his manufacture of lithographic impressions taken by rollers in black ink, and graduated tints of different colours. These rollers are composed of iron, covered with an elastic body of felt-cotton, and this again with an envelope of leather, chemise en lair, so neatly fitted as to render the jointing as near as possible imperceptible to the naked eye. Looking to the importance of having well constructed rollers in the lithographic art, and the superior manner in which those of M. Schnautz were executed, the Bronze Medal was awarded to him.

M. Brisset's lithographic press.

M. Brisset, of Paris, exhibited an iron lithographic press (No. 1390 in Catalogue) of the same construction as those generally employed in workshops for lithographic purposes. The price of M. Brisset's machine is 900 francs, if the framing be of iron, and 600 francs if made of wood. This press has a supplementary framing, with transverse bars, and in these are point-holes for the purpose of adjusting the register when required to take more than one impression upon the same sheet. This arrangement of the parts is of some importance, as two or more colours can be taken by these means on the same sheet. These constructions, and other minor points of improvement, obtained for the machine the Bronze Medal.

Hand machine of M. Thuvien.

M. Thuvien exhibited a hand-machine (No. 1,413 in Catalogue) similar to that used for letter-printing, and known as the "Stanhope press," but with the difference that the space between the table and the faller is sufficient to admit the lithographic stone in place of the type. In addition to this arrangement, M. Thuvien has established a supple-

mentary plate of such thickness as to make up the difference of height suitable for lithographic impressions. In fact, it is neither more nor less than the printing press converted, and by these means it answers the double purpose of lithographic and typographic impressions. The tympan of this press, like some others already described, has point-holes, which enables the operator to give different coloured impressions, similar to those produced by M. Brisset's machine. For these contrivances, and other considerations of minor importance, M. Thuvien was awarded with the Bronze Medal.

Enlarging or reducing machine of Messrs. Cellerin & Devellier.

Messrs. Cellerin and Devellier, Paris, contributed a machine for enlarging or reducing designs. It is very ingenious, and consists of a circular table, with the edges rounded. Upon this table is stretched a sheet of vulcanized india-rubber, of about three millimetres thick. The edges or circumference of the india-rubber are drawn tight, and fixed to a circular ring, which regulates the caoutchouc by a screw that increases or diminishes the tension. Hence an impression taken when the caoutchouc is half stretched can be enlarged by lowering the ring, and, *vice versâ*, the impression can be diminished by raising the ring. The impression of the design or the engraving required to be enlarged or reduced is first traced upon a sheet of gelatine or calking paper; it is then laid upon the vulcanized rubber, and when the size of the impression is fixed, two or three enlarged or reduced proofs may be taken, in their relative proportion the same as the original.

The utility of this machine is obvious in facilitating the operations of artists and designers for stuff, printing upon coloured paper, wood engraving, and vignettes; and considering all these advantages, and the improvements effected by this process, the bronze medal was awarded to Messrs. Cellerin and Devellier.

Machines and presses of Messrs. Heim Brothers.

Messrs. Heim Brothers, of Offenbach, Grand Duchy of Hesse, exhibited a great variety of machines and presses, remarkable for their cheapness and for the quality of the workmanship. Two-hand typographic presses were introduced, from which impressions are taken by a combination of levers. Also a lithographic press (No. 8 in Catalogue) from which impressions are obtained by a long lever and clutch fixed on one side of the press. This lever and clutch operate upon two shorter levers, one on each side, with connecting rods across the *rateau*. The motion of the impression table is effected by racks and pinions on each side of the press, and the whole of the operation is very simple, and may be established at a comparatively small cost. In addition to the above, there are two presses for cutting paper, two others for giving impressions in relief upon skins, with the table resting upon springs. These are chiefly employed

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in book-binding. A machine, with a curved knife, for cutting pasteboard, was also exhibited; the peculiarity of this instrument is the angle at which the knife is set, in order to place the edge in the most favourable position for the operation. Another press, with steel rollers, and table covered with steel plates for glazing and polishing, completes the series of Messrs. Heim Brothers' constructions; and, looking at the sacrifices made in the exposition of so many articles of value, and the utility of these different instruments of industry, the Bronze Medal was scarcely considered an adequate compensation.

M. Busser's press.

In the department of lithography, M. Busser, of Paris, exhibited a press of the ordinary construction, but with this modification, that the movement of the rubber *rateau* is effected on each side of the press, in order that the *rateau* should always be in a position parallel with the surface of the stone. The arrangement gives sufficient elevation for the movement of the *rateau;* but in ordinary presses, where the pressure of the *rateau* is produced from only one side of the press, it becomes necessary to use a spring on the opposite side, in order to obtain the required elevation between the *rateau* and the tympan. These modifications constitute the principle improvements of the press, and for them a recompence of Honourable Mention was given.

Miscellaneous Machines for various Purposes.

Immense variety of this class of machines.

It would prove an endless task to attempt a description of the contents and immense variety of this class of machines. Those for the manufacture of hooks and eyes, grinding, compressing, and folding in paper chocolate cakes, washing, cleaning, and corking bottles, cutting ivory, shell, and bone for combs, and machines and tools for the manufacture of brushes, may be enumerated as a sample of the curiosities of this numerous list.

Machine for compressing and folding chocolate in paper.

The machine for compressing chocolate into cakes and folding it in paper coverings was a clever and most ingenious contrivance; it was designed by a young man from a verbal description given by his employer of the envelope machine, which he had seen at work at the Exhibition in 1851. Its operations in forming the cakes were well performed; and such was the exactitude of its motions in folding the paper and sealing it with red wax, that the human hand could not have done it with greater precision. The levers, pliers, and folders were equivalent to so many fingers, which handled the package with a degree of certainty highly creditable to the ingenious contriver of the machine.

Machine for the ma-

There was also a well constructed machine for the manufacture of hooks and eyes; it was driven by steam-power,

like the chocolate machine, and manufactures all sizes, from the largest clasp to hooks and eyes hardly perceptible to the naked eye. Like the card-making machine, it cuts and bends the wire, forms it into loops, and stamps it to the required form with the greatest rapidity and precision. It manufactures four or five times as many as could be made by the old hand process in the same time.

Manufacture of hooks and eyes.

Amongst other machines exhibited, that for moulding bevel, spur, and other wheels deserves mention, and is said to possess the following advantages:—The ability to give to the teeth of each wheel a true epicycloidal or other form that may appear advisable; great saving of time and expense in making patterns, as a short segment only is required for moulding the wheel. It further enables the attainment of much truer wheels than could be produced on the old plan, and hence gearing made by this machine may safely be run at much greater speed than that of the ordinary construction.

Machine for moulding bevel, spur, and other wheels.

Its advantages.

Fig. 12 is a vertical elevation of the machine, showing the moulding box and apparatus connected with it.

Description of it.

Fig. 13 is a plan of the machine.

It consists of a vertical spindle A, with a horizontal table or face plate B upon it; this spindle works in the conical bearing formed in the frame C. The foot of the spindle A is supported by four diagonal struts D D, extending downwards from the frame C, which supports the table B, and everything that is laid upon it, by means of the footstep E, by which the table can be raised at pleasure in the conical bearing in the frame C, thereby enabling the workman to turn the table round with very little force and perfect steadiness, though bearing a great weight.

F F is a horizontal slide bed attached firmly to one side of the frame C; upon this slide is moved the sliding jib G, carrying at its extremity the vertical slide H. A rack I I is attached to the slide bed, into which works a pinion on the shaft J, driven by bevel wheels and the crosshandle K. By means of this apparatus the vertical slide H can be placed in any position over the table B, or removed clear from it on either side.

The set screws L L are for the purpose of fixing the sliding jib firmly upon the bed, and holding it in any position that may be required.

The vertical slide H is moved by a rack and pinion worked by a handle and shaft M, and is rather more than counterpoised by a weight T attached to a chain passing over a pulley at top. A ratchet wheel with pall is fixed upon the handle M, to hold the slide from being drawn up by the balance weight, or forced up by the moulder; and the balance weight is made a little in excess, to insure a pressure always upwards against the ratchet.

Fig. 12.

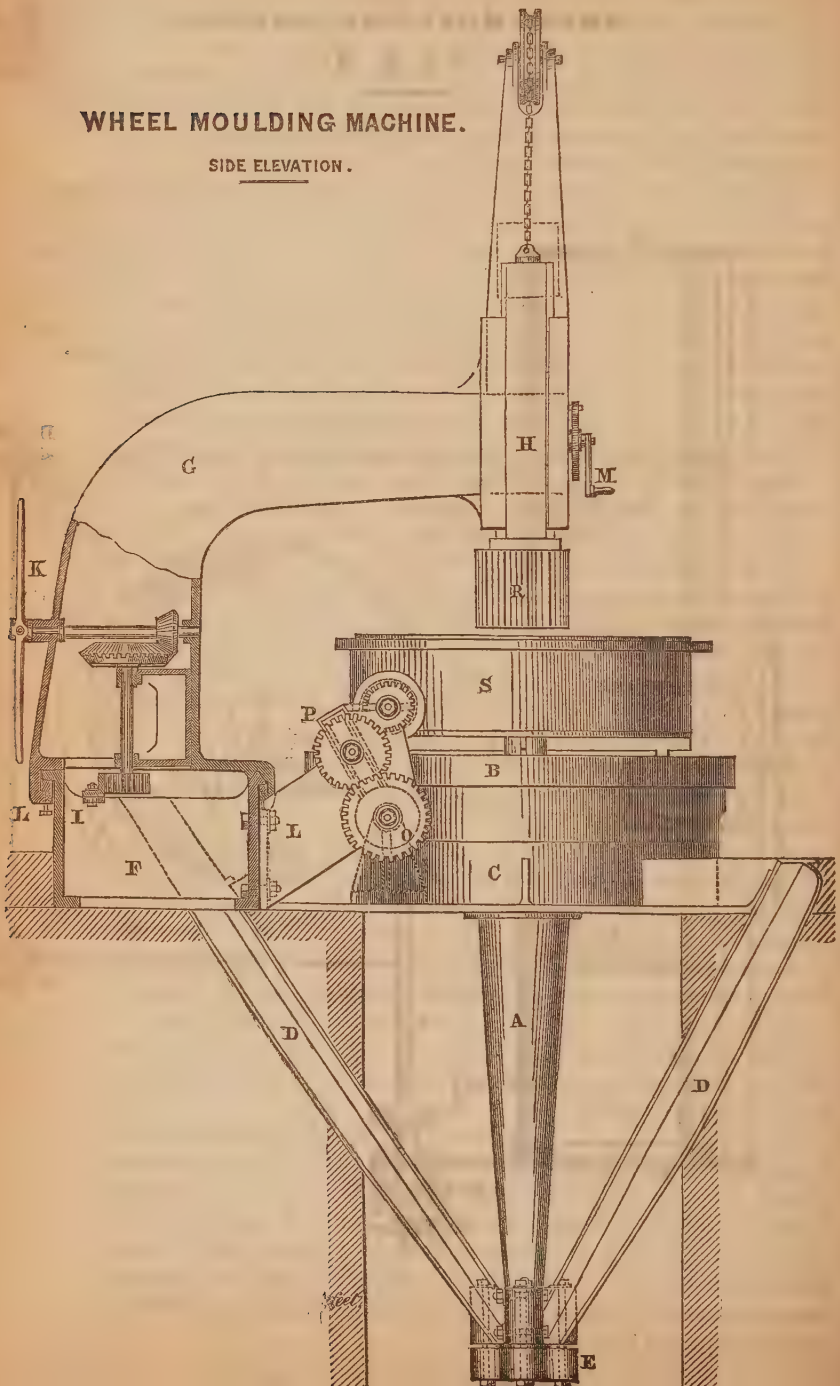
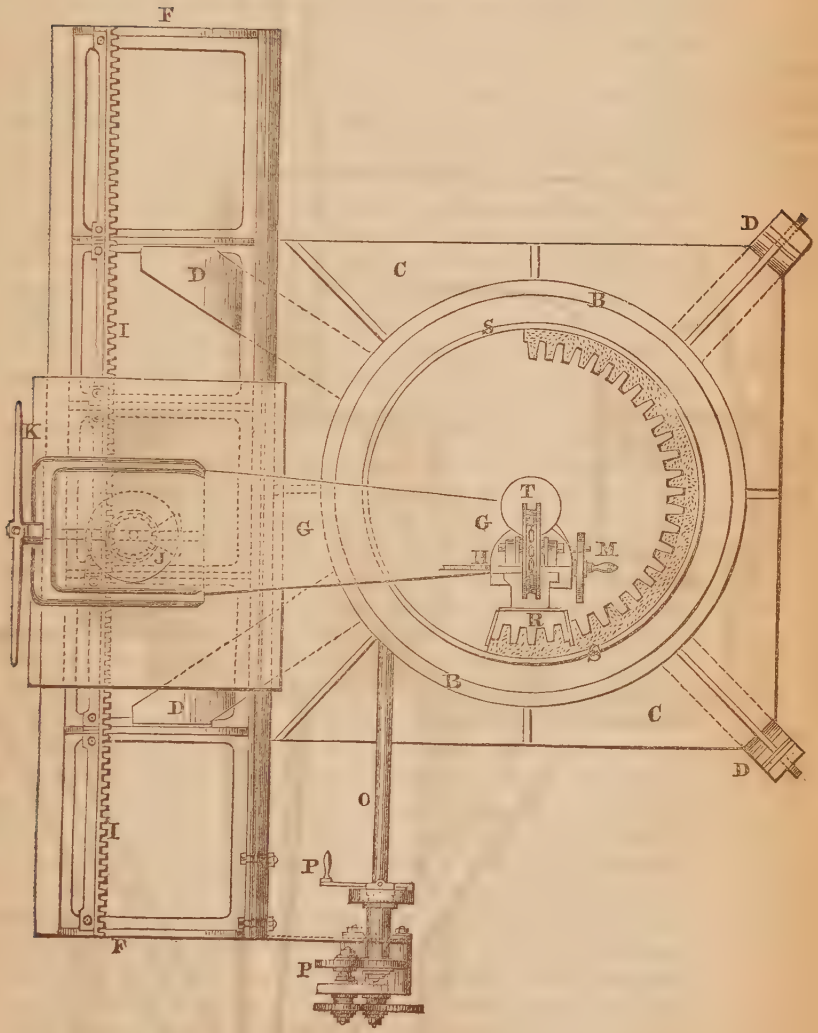

WHEEL MOULDING MACHINE.
SIDE ELEVATION.
G
H
M
K
R
S
P
B
L
I
L
O
F
C
D
A
D
E

Fig. 18.

WHEEL MOULDING MACHINE.

PLAN.



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A worm wheel is fixed upon the underside of the circular table B, and is moved by the worm and shaft O, turned by the handle and change wheels P, similar to an ordinary dividing or wheel-cutting engine. By turning the handle P the required number of times, having previously adjusted the change wheels to suit the number of teeth in the wheel intended to be moulded, the circular table B is moved round an interval equal to the pitch of the wheel, and this movement can be accurately repeated through any part of the circumference.

Manner in which wheels are moulded by it.

The short segment pattern of the wheel to be moulded being attached to the vertical slide H, and the moulding box to the table B, the segment pattern is brought down by the slide till it rests on the levelled sand intended to form the bottom of the mould, the top of the segment being level with the edge of the moulding box; the moulder then rams up in the ordinary way that portion of the box opposite the segment pattern by means of the slide H, and then turns the circular table B, by the handle P, through an interval equal to the number of teeth contained in the segment pattern; the pattern is then again lowered and the ramming up of the mould proceeded with in the new position of the box; and this process is repeated till the whole wheel is moulded.

Machines for setting up and distributing type.

Machines for setting up and distributing type.—Three of these were exhibited, two from Belgium, and one from Copenhagen. One of the Belgian machines was for setting up, the other for distributing by the movement of keys alphabetically arranged. In the Copenhagen machine, invented by Mr. Sörensen, these two operations were performed by one machine, the distributor being above, and the composer below. All these machines exhibited great skill and ingenuity in the arrangement of the grooves or conduits for conveying the types to the composer as they were struck off by the distributer. Mr. Sörensen's machine consisted of a cylinder about 16 inches in diameter, the upper part of which contains grooves, in which the type is arranged. From this part of the cylinder they are dropped into their respective grooves by action of keys, like those of a pianoforte, as the compositor spells the words; the grooves convey them to the composing stick, and arrange them side by side. All the type was of the same length and thickness, and the machine is admirably contrived to insure their falling with their heads up into the channels which convey them to the composing stick, where they are divided into lines according to the size of the page. Mr. Sörensen's machine was beautifully made, and its operations, in the hands of its inventor, were highly satisfactory, and well deserved the commendation of the Jury.

Mr. Sörensen's machine.

Conclusion.

It is to be regretted that we have no statistical accounts on which reliance can be placed, of the condition of the working classes abroad, as compared with that of the English operatives; judging, however, from what I saw of the condition of the population in Paris and other parts of Europe after the peace of 1815, and during several subsequent visits, I should infer that the whole working population of the capitals and large manufacturing towns has undergone a considerable change, and is still in a state of transition. The increase of manufactures of all kinds, and the earlier introduction of railway communication, have rendered this change more strikingly apparent in our own than in foreign countries, and the population of Great Britain has already felt, and in some degree accommodated itself to these influences, which abroad are only beginning to produce their results; and on the Continent the effects of a transfer from one system of operations to another are now developing themselves.

Changes in the condition of the working classes.

The French *ouvriers* are active, intelligent, and well employed; the German, Swiss, and Belgians, patient and enduring: and although foreigners may take a longer time in executing work than English workmen, they are nevertheless expert, and in many cases better educated, and therefore better able to cope with the difficulties and surmount the obstacles in the way of a successful progress.

Foreign workmen.

I do not mean to intimate that the mass of the workmen abroad are better educated or better informed in the practice of their respective callings than in England, but I firmly believe from what I have seen, that the French and Germans are before us in a knowledge of the principles of the higher branches of industrial art, and I think that this arises from the greater facilities afforded by the institutions of those countries for instruction in the chemical and mechanical sciences.

French and Germans before us in the higher branches of industrial art.

When reporting on the manufacture of iron, I endeavoured to show that, notwithstanding the natural resources placed at our disposal, the quality of our cast iron is not to be depended on, that under the powerful stimulus of self-aggrandizement we have perseveringly advanced the quantity, whilst other nations, less favoured and less bountifully supplied, have been studying with far more care than ourselves the numerous uses to which this material may be applied, and are in many cases in advance of us in quality.

Inferiority of the quality of our pig iron.

I also adverted to the advantages of the employment of iron as a building material, and pointed out that the education of that important class of men, the architects, who give

Culpable neglect of iron in construction

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taste and character to a community, is behind that of other countries. The architects of Great Britain have not availed themselves of the use of iron in construction to the extent they might have done; that it should be so energetically and profitably employed in buildings in France, where its cost is nearly double what it is here, is a reflection on the intelligence and enterprise of a profession that has always stood, and I hope will continue to stand, high in the estimation of all who wish well to their country and to the advancement of the industrial arts.

by our architects.

Machinery for the production of the textile fabrics.

Several ingenious contrivances have from time to time been brought forward by our Continental and American competitors in machinery for the manufacture of the textile fabrics, and a friendly rivalry has always existed amongst the contributors to this department, and has had the best possible influence on the progress of the manufacture. Great Britain has assuredly every reason to be proud of the position she holds in regard to this division of the mechanical sciences; to maintain it she must exercise the same skill and indomitable perseverance which have marked her past career; and so long as the same inducements are in operation, and the similar encouragements for active exertion are held out, her spirit of enterprise and energy of execution will lead to the best results.

Superiority of Great Britain in this branch of industry.

Progress made in mechanical engineering.

I have already expressed my opinion of the great progress that has been made in the construction of steam engines, iron bridges, and machinery, wherever the railway has made its appearance, and in this department our superiority is not so strikingly marked, and although we still take the lead, we are not much in advance of others, as the engines exhibited at Paris fully proved. In marine constructions we are still superior to all other nations; but abroad rapid advances are making in that direction also, as was evidenced by the engines of the Mortala works in Sweden, which were admirably made, both as regards simplicity of form and compactness of construction.

The marked superiority of our millwork.

In the construction of millwork this country stands unrivalled; and although repeated attempts have been made to imitate the transmissive machinery of our manufacturing districts, they have not been as successful as might have been expected; and our millwrights stand alone for neatness of design and judicious proportion of the parts of the transmissive machinery employed in all the branches of that useful department of industry.

Great superiority of our tools for workshops.

In the manufacture of tools for workshops we are also unequalled, as with one or two exceptions the tools of foreign construction will not bear comparison with those of this

country. The same cannot be said of the lighter descriptions of machinery and instruments of precision; in many of these constructions the French, Germans, and Swiss are even in advance of the manufactures of this country. Mediocrity of our lighter descriptions of machinery.

With the exception of reaping machines, in which America excels, our agricultural implements, including those for working plastic materials, are superior to those of most countries, and this superiority appears to be due to the variable nature of our climate, which necessitates an improved system of culture and the use of machines calculated to save time and to insure success to the labours of the farm. Superiority of our agricultural machines and implements.

In conclusion, it only remains to state that the Paris Universal Exhibition of 1855 and that of London in 1851, have produced their proper effects. They have shown to the world, in every department of industry and of practical science, wherein consists the prosperity of nations and the happiness of mankind. They have shown how all materials, whether derived from the forest, the field, or the mine, may be turned to purposes of utility; how the labour of man may be multiplied a thousandfold; how the fruits of the earth may be cultivated and gathered in for man's necessities; and how works of art may be elaborated to increase the happiness and enjoyment of his existence. All these things were exhibited on a scale commensurate with the greatness of an undertaking so vast in extent, so varied in form, and so characteristic of all the duties and wants of human existence, as to elicit the admiration and praise of astonished multitudes from every country of the civilized world. Good effects of the National Exhibitions of 1851 and 1855.

I have the honour to be, &c.

W. Fairbairn.

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Appendix No. 1.

Mr. K. Blackwell's valuable paper.

The very valuable paper of Mr. J. Kenyon Blackwell, F.G.S., entitled "The Present Position of the Iron Industry of Great Britain with reference to that of other Countries," contains views and opinions so similar to my own on the manufacture of iron, that I have applied to the author and obtained his permission to give some extracts from the paper, as an Appendix to the foregoing Report. In speaking of the quality of the fuel, and its chemical and mechanical effects in the reduction of the ores in the blast furnace, Mr. Blackwell states, that "The fuel employed in the reduction of ores in the blast furnace possesses this reducing power only in respect of, and in proportion to, the carbon which it contains. Whether, therefore, it be wood or coal, the question regarding its employment in the raw state, or partially or wholly carbonized, rests solely on the circumstance whether it can be more perfectly and economically carbonized in the open air, in closed ovens, or in the blast furnace itself."

Reducing power of fuel due to carbon only.

Similarity of vegetable and mineral fuel.

"The differences in the chemical nature of the various elements, forming on the one hand vegetable and on the other mineral fuel, are only in degree and not in kind, except in so far as regards the composition of the earthy residuum of ashes left after the volatilization of the other elements. It may, therefore, be in the different nature of the substances present in the ashes of wood and of coal, that we must seek for the explanation of the causes which produce such a widely different quality in iron smelted with these two species of fuel. Sufficient attention has not hitherto been paid to ascertaining the exact nature of the diversities in the composition of this portion of the constituents of wood and coal, and of different varieties of coal.

Neglect of mechanical cleansing operations in this country.

"The mechanical operations, by which a large part of the earthy impurities of all coal-seams of a caking nature might be separated from them before they are converted into coke, have been hitherto generally neglected in this country.

"Abstraction being made of these variable constituents (a large part of which are only present in coal as impurities), no distinct line of demarcation, founded on the chemical nature of the two bodies, can be drawn between wood on the one hand and coal on the other. Both are composed essentially of carbon, hydrogen, oxygen, and nitrogen. Oxygen is present in the largest quantity in wood, while its proportion is lowest in the most highly mineralised or anthracite coal.

Classification of substances used as fuel.

"The whole of the combustible bodies of this nature range themselves in one general series, the different classes of which may be divided into the following seven species, in accordance both with the physical characters which they exhibit, and at the same time their greater or less degree of oxygenisation, namely, wood, lignite, cannel or splint coal, non-caking coal yielding a long flame, caking coal, non-caking coal yielding a short flame, and lastly, anthracite.

"It has already been observed, that the fuel employed in the blast furnace, possesses a reducing power only in proportion to the quantity of carbon which it contains, and that the question whether this fuel ought to be used in its raw state or carbonized, and whether the coke or charcoal into which it must be converted should be prepared in open fires or in close ovens, depends solely on the quantity and quality of the coke or charcoal which will be obtained from it by these various systems, and the comparative economy with which they can be prepared."

The latter part of these observations are of great importance, as the coking of the coal and the combination of the ores have considerable effect on the quality of the iron produced; and it is only in some localities, where the ores and fuel contain only a very small per-centage of sulphur and phosphorus, that iron of great strength is obtained. On the subject of fuel, Mr. Blackwell goes on to observe:

Caking coals.

"Those species of coal which it has been found most easy to employ in the blast furnace, have been the non-caking varieties. Caking coals require to be mixed with coke to a greater or less extent, to prevent the adhesion of the whole of the fuel in one mass.

Advantage of carbonizing the fuel before introduc-

"Notwithstanding the great extent to which raw coal and partially torrified wood have been long used in the blast furnace, both in this country and abroad, it certainly appears, on a careful consideration of the nature of the process to

which both coal and wood must be subjected, either within or out of the blast furnace, before the carbon which they contain can be utilised in the reactions of the furnace, that their carbonization may be effected with most economy, and that the quality of the charcoal or coke which results from this process will be best, when effected in close ovens, prior to the introduction of the fuel into the blast furnace, and not within the furnace itself.

tion into the blast furnace.

"When wood or coal are coked at a low temperature, the hydro-carbon products, which carry off a large quantity of carbon, are formed much more abundantly than when this operation is conducted at a high temperature. Under the influence of high temperature, the hydrogen of these substances passes off either alone or in its proto-carbonated state. If wood or coal are coked in closed ovens, the degree of heat to which they are subjected in that process, and its duration, which is necessary to harden the product, can be controlled. When this operation takes place in open fires, or in the blast furnace itself, these two conditions cannot be regulated with the same facility, nor can the supply of oxygen to the incandescent carbon be determined with the necessary exactitude to limit its supply simply to that necessary to obtain the requisite temperature. The form adopted in the construction of the coking oven is an important element in obtaining the requisite temperature.

Temperature best for carbonizing fuel.

"Coal and wood not only give the highest yield in coke and charcoal, when their carbonization is conducted at an elevated temperature, but they are found to be superior in quality, and better fitted for use in the blast furnace, when they have been subjected for a considerable time to the action of this elevated temperature, than when they have been coked rapidly at a low heat. It is, moreover, important that the temperature to which they are subjected should be raised to its highest point as soon as possible after the carbonization commences. These necessary conditions can only be obtained by coking in close ovens.

"The system of coking in close ovens possesses another advantage, in permitting the utilisation of the heat afforded by the combustion of the waste gases of the coal in the raising of steam. Many of the largest Continental works derive the whole of their supply of steam from boilers set over their coke ovens."

Generation of steam by the waste gases of the coking process.

The generation of steam by the combination of the waste gases, is a consideration of great importance in every country where the smelting process is carried on. It is not enough to say that fuel is cheap: that circumstance is no excuse for wasteful extravagance; and the French and Belgian manufacturers are fully aware of the advantages which this highly commendable process affords, and employ it in all those localities where steam power is required in the immediate vicinity of the coking process. I strongly recommend the use of the waste gases for the generation of steam.

On the separation of earthy impurities from the ores in the process of smelting, Mr. Blackwell is particularly clear and explicit. He states that "The separation of the iron in a metallic state from the earthy matters and impurities contained in its ores, is effected most perfectly in the blast furnace, when the heat of the furnace is sufficient to produce at least a medium degree of carburation in the iron, and when there is a sufficient amount of lime present as flux to produce a fluid cinder. White or imperfectly carburised iron usually contains the whole of the sulphurets of the ores, and probably variable quantities of unreduced oxide, and of the earthy matters contained in the ores mechanically mixed with it; at the same time the heat of the furnace not being sufficient to effect a perfect reduction of the ore, a large quantity of oxide passes into the slag in the state of silicate. In this country, in South Wales especially, very large losses are constantly sustained by the iron-masters by this imperfect smelting.

Reduction of iron.

"The oxide of manganese, found in larger or smaller quantities in almost all ores of iron, is to a great extent reduced in the blast furnace and passes into the pig iron. It is partially or wholly removed by oxidation in the subsequent processes of the refining and puddling furnaces.

Manganese in the ores of iron.

"An elevated temperature in the blast furnace has a tendency to reduce a portion of the silica contained in the ores to a metallic state, when it enters as an alloy into the crude iron. The same cause appears to act to a minor degree in producing to a small extent the reduction and alloy of other bodies present in the furnace; but silicium and other metals of this class are entirely, or in great part, eliminated in the subsequent oxidising processes of the refining and puddling furnaces.

Reduction of silica with the iron.

Decomposition of sulphuret of iron.

"The sulphurets of iron contained in the ores of that metal, and often, even more largely, in the mineral fuel used in its reduction, are partially, but not wholly, decomposed in the blast furnace. An elevated temperature and the presence of lime aid this decomposition, and the elimination of the sulphur as sulphuret of calcium.

Reduction of phosphuret of iron with the metal.

"The phosphate of iron contained in these ores is reduced to the state of phosphuret in the blast furnace, and passes entirely into the pig iron. This substance has been found, but only rarely, in furnace slags as phosphate of alumina; it may possibly have existed in that combination in the ore previous to smelting. The phosphuret of iron which is reduced in the blast furnace, is again subjected to oxidation in the refining and puddling furnaces. It passes partially or wholly into the slags, which are separated in those processes."

Hot and cold blast iron.

The next question which attracts attention is the comparative merits of the hot and cold blast in the process of smelting. He states that "Much controversy has taken place with respect to the difference in quality supposed to exist between pig iron smelted with cold and with hot blast. While no doubt could exist with respect to the economy of fuel, the greater regularity in the action of the blast furnace, and the larger quantities of metal obtained under equal circumstances by the use of the hot blast, it has generally been considered that the pig iron smelted with hot was inferior in quality to that produced with cold air. Undoubtedly, this opinion has been created to a great extent, from ignorance of the facts of the case. Furnaces blown with heated air exert greater reductive power than those in which a cold blast is used. This has led, since the introduction of hot blast, to the extensive usage in iron smelting of refractory ores not formerly smelted, a large part of which have been ores of a class calculated to produce inferior iron; and it is from the use of ores of this nature, far more than from any deterioration in quality arising from the use of a heated blast, that this opinion has originated.

"At the same time it appears to have been proved, that the more elevated temperature of the hot blast furnace has a tendency in a slight degree to increase the quantity of silicium and other cognate metals, which form alloys with pig iron in the smelting process. Phosphuret of iron is said to have been found to a minutely increased extent, in combination with pig iron smelted by hot air, when compared with that obtained from the same minerals by cold blast. On the other hand, the sulphurets of iron appear to be removed to a greater extent by the agency of hot air. The subsequent oxidising processes in the conversion of pig into wrought iron, eliminate in part, or wholly, these foreign metals as oxides, and the phosphuret of iron as phosphate in the slags produced."

Other causes of the inferiority of hot-blast iron.

On this important subject Mr. Blackwell appears to consider that the introduction of the hot blast has led to the reduction of inferior ores, and that the cause of deterioration in the iron has arisen from that cause. To some extent this may be the case; but we must look to another cause for a great many of the anomalous conditions of iron from the same furnaces. If it could be traced to the ores alone, there is at once an answer to the difficulty; but the use of raw coal and uncalcined ore, with an elevated temperature arising from the heated air, has doubtless something to do with the variable products which proceed from the process. Time, and the purification of the ores and fuel previous to smelting, appear to be essential to the production of good iron, and hence it follows that the high temperature, together with the impurities of the raw material, is much more likely to produce iron of inferior quality than the old process with duly prepared ores and fuel. I offer this opinion from no feeling of opposition to Mr. Blackwell's superior chemical attainments, but from a knowledge of the different results from the same ores and same fuel at different times.

Mr. Blackwell's observations on the conversion of crude iron into the malleable state are so forcibly given, and so much to the purpose, that any observations upon them would rather tend to obscure than render them more explicit. I therefore give the quotation in his own words.

Conversion of crude into malleable iron.

"The carburised crude iron obtained in the blast furnace is converted into malleable iron by one or more operations, all of which are of an oxidising character. By these it is sought to separate the carbon combined with the iron in the gaseous form as oxide of carbon, whilst the metallic bodies, forming alloys with it, and the phosphuret of iron present, are also oxidised, and pass partially or wholly into slags.

Catalan fire.

"In the Catalan fire, one of the earliest forms of the blast furnace, all the varied processes required to produce malleable iron were combined in one operation. The production of carburet of iron took place in the upper part of the hearth, (the fluidity thus acquired separating the metal from the earthy matters associated with it in the ore,) and this carburet was subsequently decarburised, to a greater or less extent, in the lower part of the hearth, by the reactions resulting from the effect of the blast, of the oxide of iron produced under its influence, and of that remaining unreduced in the slags formed. In the production of natural steel, the skill of the workman arrested this decarburising action at the necessary point.

Modern system.

"In the modern system these operations are subdivided. The pig iron produced with charcoal, when its conversion into malleable iron is to be completed with charcoal, is decarbonized in the charcoal refinery, with or without an intervening process termed *mazéage*. Charcoal pig iron, wherever mineral fuel is accessible, is now, however, generally converted into wrought iron in the puddling furnace with coal. Pig iron produced with coke is either subjected to a preliminary decarburation in the oxidising blast hearth, termed also in this country a refinery, and the operation thus commenced is afterwards completed in the oxidising air-furnace, termed the puddling furnace; or, in recent practice, the complete decarburation of the crude iron is effected without the intervention of the refinery in the puddling furnace, by the process called boiling.

Production of steel direct from the ores.

"It is said that, at several works abroad, the attempt to arrest the process of decarburation in the puddling or boiling furnace at that point in which the conversion has proceeded only so far as to leave the iron in the state of steel, or subcarburet, has been successful; and that a valuable natural or puddled steel, not requiring cementation before conversion into refined or cast steel, has been the result.

Processes for conversion of crude into malleableiron are processes of oxidation.

"All the processes employed in the conversion of crude or carbonized iron into malleable iron, are processes of oxidation, in which the carbon is removed either by direct oxidation, or by the reactions occasioned by the presence of oxide of iron formed or introduced during the process. The presence of oxide of iron in excess appears necessary in all these processes to form fusible slags, consisting essentially of silicate of iron, in which the silica and other bodies, separated by oxidation from the iron, or present accidentally, are wholly or partially removed.

"The question for investigation, in examining the nature of these various processes of conversion is, therefore, whether the removal of the carbon of the crude iron, and at the same time the elimination of the impurities contained in it, is effected with the smallest possible waste by oxidation of the iron subjected to them.

Faulty character of present systems.

"That the present systems of procedure are frequently extremely faulty, appears to be a necessary deduction from the fact, that in some of the largest iron-making districts of Great Britain the production of one ton of wrought iron of inferior quality is only obtained by the consumption of nearly one and a half tons of crude or pig iron

Crude iron best adapted for conversion into malleable.

"The crude iron from which wrought iron of the best quality is produced, is that possessing a medium degree of carburation, or what is usually termed grey pig iron. White iron, which possesses an inferior degree of fluidity to grey pig iron, and which comes, as it is termed, more rapidly to nature, is that quality which is most generally employed in the manufacture of wrought iron, especially when the conversion is effected by the single operation of boiling in the puddling furnace; but this species of pig iron, being the result of imperfect reactions in smelting, is always more impure than grey or more highly carburised pig iron obtained from the same materials, and does not produce wrought iron of the best quality.

Results of conversion of charcoal iron by coal;

"In those countries in which the pig iron produced is smelted with charcoal, but coal is available for conversion into malleable iron, the charcoal refinery is generally abandoned for the puddling furnace, it being found that the quality of the iron resulting from the latter process is sufficiently insured by its previous treatment in the blast furnace with charcoal.

and of coal iron by charcoal.

"In Great Britain, where the smelting process is almost exclusively conducted with coal or coke, it is found that nearly the same result can be obtained, with

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reference to the quality of the bar iron produced, by the treatment of the pig iron thus smelted, in its final stage of conversion into wrought iron, in the charcoal refinery with charcoal.

"It is an important subject for investigation to ascertain what are the precise causes to which this amelioration of quality from the use of vegetable fuel is due, when used in the treatment of iron in processes which have no analogy to each other. The circumstances of the two cases appear to point to the possibility that the eliminative effect exercised as fluxes in both instances by the ashes of the vegetable fuel employed, may have some effect in producing this improvement in quality. Should such really be the case, we may then replace charcoal as fuel with advantage in those cases in which it is still employed, by the use of artificial fluxes producing an equivalent effect.

Process of coke refinery and mazéage.

"The coke refinery or running out fire occupies in this country, by its results, the same position with reference to the charcoal refinery as the process termed *mazéage* on the Continent. Previously to the introduction of the process termed boiling (in contradistinction to puddling) in the treatment of iron in the puddling furnace, the whole of the metal puddled was subjected in the first instance to the oxidising and decarburising process of the coke refinery. Refined metal is still used to a large extent, either alone or mixed with pig iron, in the puddling furnace in this country. It is also employed exclusively in the charcoal refinery.

"The pig iron to be decarburised in the refinery is usually melted with rich silicates, and occasionally with oxides of iron, intended, as in other processes of this nature, to protect the melted iron in some degree from the oxidising effects of the blast, and to react on the carbon which it contains. The quantity employed depends on the degree to which the pig iron is carburised.

"In the presence of silica in excess in the refinery hearth, the oxide of iron formed by the blast is not reduced by the carbon, but is lost by entering into the slags. It is, therefore, desirable to exclude it as much as possible in the operation. For this reason, the coke employed should be free from shale, and contain only a low per-centage of ash. Lime in small quantities may be used advantageously in the refinery, to enter into combination with the silica present, but it can only be employed to a limited extent, as it would otherwise render the slags too thick.

"It is of the utmost importance that the cokes used in this process should be as free as possible from sulphuret of iron, which they often contain largely. The greater part of this sulphuret present enters into combination with the metal, and does not pass off in the slags.

"Phosphuret of iron, if present in the pig iron, appears to be converted into phosphate, and enters into the slags. It is found largely in many refinery cinders which have been submitted to analysis.

Loss of iron in refinery process.

"The loss of iron in the refinery process is very large. It varies from 10 to 20 per cent.

Charcoal refinery.

"The charcoal refinery in general use in those countries where mineral fuel is not accessible for the conversion of crude into malleable iron, is still employed in this country, when it is desired to produce iron of the best quality. It has already been observed that the causes of the amelioration in the quality of iron smelted and partially decarburised with coke, when the last stage of its conversion into wrought iron is effected by the agency of charcoal in the refinery fire, forms an important subject for investigation.

"The charcoal pig iron treated in these fires is usually that termed white, or mottled, which is selected on account of the less degree of fluidity which those qualities possess, and the greater rapidity with which they come to nature. When grey pig iron is used, it is ordinarily decarburised, to a certain extent, by some of the processes termed *mazéage*. In this country, where iron smelted with coke is thus treated, grey pig iron possessing a medium degree of carburation is generally employed, on account of its greater purity, as compared with white or mottled iron; but it is always converted into refined metal in the coke refinery prior to its use in the charcoal refinery.

Fluxes, strictly speaking, are not used in the charcoal refinery. They would not be advantageous unless the metal treated had been imperfectly refined in the coke refinery, the silicium of the pig iron and the silica accidentally present being removed by that process. The oxides of iron from the hammer and the subsilicates formed in the charcoal refinery during the latter part of the operation, are

returned to the fire, where they in some degree protect the metal, as it subsides in the hearth, from the too long continuance of the decarburising effects of the blast, whilst they also exert on it, by reaction, a similar influence, accompanied by a reduction of a part of the oxide which they contain.

"The melted and partially decarburised iron is raised, as it sinks in the refinery hearth, in order to expose it in every part to the action of the blast, and this operation is repeated on the collected mass, which is again brought to the surface of the fire, re-melted and sunk before the blast, until the whole is found to be sufficiently decarburised and refined throughout.

"In estimating the precise nature of the effects produced in the charcoal refinery, it is necessary to observe that this fire, in common with all blast furnaces, contains, at the same time, at different elevations, a carburising and deoxidising, and an oxidising and decarburising zone. The imperfectly converted and imperfectly purified metal under treatment can, therefore, by a simple change of position in the fire, be re-subjected to the reactions which take place in it, until the effects desired are perfectly accomplished.

"The conversion of crude into malleable iron is now effected on the largest scale, both in this country and abroad, in the reverberatory furnace, termed a puddling furnace. The actual process followed is termed puddling or boiling, according to variations in the degree to which it is necessary to carry the reactions of the furnace, according as partially decarburised or refined metal or pig iron is treated. Puddling.

"The term puddling is applied to that process in which refined metal, previously partially decarburised and separated from the impurities it contained in the coke refinery, is converted into malleable iron by subjecting it to the action of a current of heated air excited by the combustion of fuel in the reverberatory furnace in which the operation takes place. The boiling process is that in which pig iron is converted by one operation into malleable iron by the more energetic reactions induced in connexion with this deoxidising current by the more elevated temperature of the puddling furnace, and by the presence of a bath of rich subsilicates of iron.

"The bottom and sides of puddling and other furnaces used in the conversion of iron ought to be constructed of cast iron, kept cool either by currents of air, or, in those portions exposed to the greatest heat, by water, to prevent the re-action which would take place between the oxides of iron formed during these processes and the silica of a brick lining. The silica, which might be introduced accidentally, ought to be carefully excluded, as its presence must occasion unnecessary loss in the operation. These points are not always attended to with sufficient care.

"The cast-iron bottom of the hearth is covered by a layer of scoriæ or silicates of iron. It is found that those slags which are the richest in oxide of iron, and in which the oxides have been converted into the state of sesqui-oxide by calcination, offer the greatest resistance. The cinders of the charcoal refinery are much esteemed for this purpose. When melted into one uniform mass, with the addition of oxide of iron, these scoriæ form a bottom, offering great resistance to the action of the melted metal.

"It has already been observed that in the process of puddling, refined metal only is used, and that its conversion into malleable iron is effected solely by the reactions induced by the current of air excited by combustion in the reverberatory furnace. This operation is effected at a lower temperature than boiling, and without the addition of the oxides and subsilicates employed in the boiling process in conjunction with a more elevated temperature, to produce the more energetic reactions required in the latter.

"The process of boiling is that which is now almost generally used for the conversion of pig iron into malleable iron by the agency of mineral fuel. Its nature permits it to be employed for this purpose, without the introduction of any process of decarburation similar to the coke refinery. Grey pig iron, smelted with coke, may be converted into malleable iron by this single process, thereby avoiding the serious waste incurred by oxidation in the coke refinery, at the same time that the use of the best qualities of pig iron without excessive waste is rendered practicable. Boiling process.

"Grey pig iron, of a medium degree of carburation, being the result of a more perfect state of action in the blast furnace than that by which white or

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mottled iron is obtained, is always more pure than iron of those classes produced from the same minerals. The length of time and amount of work which is required in the puddling furnace before grey pig iron is sufficiently decarburised and brought to a malleable state, is also to a certain extent advantageous, in respect to the quality of the wrought iron obtained from it, because this long exposure to oxidation has the effect of more perfectly eliminating the oxidable alloys which crude iron contains.

Its value.

"The process of boiling, therefore, which enables pig-iron of this class to be converted into malleable iron on a large scale without the intervention of any other process, and without excessive loss, possesses great value, and it becomes important to inquire whether there are any ameliorations which may be introduced into it which would enable it to be more universally adopted than it has hitherto been.

Its defects.

"The defects in the boiling process are the following:—the wear and tear in the puddling furnace, which occurs in treating grey pig-iron, particularly that of the more fluid descriptions; the slowness of the operation; and the amount of manual labour which it entails to produce good results.

"The reverberatory furnace possesses the advantage that in the conversion of crude into malleable iron, the oxidising and decarburising reactions necessary to effect it take place without the metal itself being at the same time in contact with the fuel, and thus subjected to the waste which would be occasioned by the earthy silicates present in the mineral fuel, generally employed, entering into combination with the oxide of iron formed. In its existing form it has, however, the disadvantage that the combustion of the fuel is necessarily very imperfect, and that neither the extent of action nor the nature of the oxidising current is sufficiently under control.

Means of improving the process.

"To produce perfect combustion in furnaces of the nature of the reverberatory furnace, the air entering them ought to be divided into two parts; one of these should pass through the fuel to excite combustion to volatilise the hydrogen present, and to convert the carbon of the fuel into carbonic oxide; the other portion should be air previously heated, and this air ought to enter the furnace under pressure, causing it to traverse the furnace at a different velocity to the current of inflammable gases derived from the fuel, since it is evident that fluids of nearly equal densities, travelling in the same direction at equal velocities, will not tend to mix and enter into combination in the same intimate and rapid manner as they would if the last entering current were heated, and if they were travelling respectively at different velocities.

"The current of air passing through the common reverberatory puddling furnace is not sufficiently under the control of the workman, either with respect to its volume or its nature. This class of furnaces would be greatly improved and rendered more effective in their action in the conversion of iron by such modifications as would enable the current of air which passes through them to be rendered either oxidising or deoxidising, as required. The effect of this change in the nature of the furnace would be to restrict the oxidising action to the exact extent necessary for removing the carbon of the crude iron, and for eliminating the oxidable alloys present, while excessive waste in the metal treated would be avoided.

"The more perfect combustion of the fuel employed, and the necessary control over the nature of the gaseous currents within the furnace, may be obtained by restricting the amount of air admitted through the ash-pit to that required for the generation of the inflammable gases, and by the application of blast to produce their perfect combustion, and to afford, as required, the necessary excess of atmospheric air for oxidation and decarburation of the metal. The supply of air, namely, that required for the combustion of the fuel and the blast, should be heated separately by the waste heat and waste gases of the puddling furnace.

Rapidity and economy of the conversion of iron in the reverberatory furnace.

"The puddling or boiling furnace is that in which the conversion of crude into malleable iron can be effected with the greatest rapidity, on the largest scale, and at the least waste and cost. It is also the furnace in which mineral, as compared with vegetable fuel, offers the greatest advantages. Where mineral fuel cannot be obtained, it is necessary to endeavour to apply those species of fuel which exist with the utmost economy. Processes of the nature above described have therefore been adopted when the use of wood, of turf, or of

the waste gases of the blast furnace have been resorted to in puddling, and with great success, under the name of gas furnaces.

American system.

"In the United States, the non-flaming character of the mineral fuel in the principal coal-bearing regions of the Atlantic States, has caused the use of the blast to be resorted to, to produce combustion and a sufficiently extended flame in the reverberatory puddling furnace. The whole system, as now explained, has been adopted extensively on the Continent to produce in puddling a perfect combustion of the waste gases of the blast furnace of wood, of turf, and, in some cases, of bituminous coal.

Fluxes used in the puddling furnace.

"The use of fluxes in the puddling furnace offers a wide field for experiment. Hitherto, their use has been generally confined to the oxides and subsilicates of iron. The energetic reactions of these oxides and subsilicates on the carbon of the crude iron, when brought in contact in a melted state, has given rise to the term boiling, but the silicates act also as fluxes by entering into fusion with and carrying off as slags after oxidation, the greater part of the alloyed metals and other impurities contained in the crude iron. The employment in addition of fluxes composed essentially of common salt and oxide of manganese, has been successful in this country in the refining of crude iron in the puddling furnace, to a degree which has permitted the malleable iron obtained from any of the ordinary classes of minerals to be used for conversion into steel of good quality. Fluxes of this nature are employed in foreign works wherever the production of natural steel has been effected in the puddling furnace. This has been accomplished not only with pig-iron smelted with charcoal from the manganesiferous carbonates of iron in Germany and in France, but also in Belgium, at the Seraing works, from pig iron smelted with coke from the ordinary minerals of that district.

Difficulty of converting grey pig iron.

"Grey pig iron smelted from a large class of ores with coke possesses so much fluidity, and retains the carbon with which it is combined with so much tenacity, as to create a great element of difficulty in treating it in the puddling furnace. In reducing crude iron of this class to the malleable state, by employing the intermediate process of the coke refinery, great loss from oxidation is incurred. From these causes it is commonly sought to obtain white pig iron from the blast furnace, and this species of crude iron (notwithstanding the inferiority in quality of the wrought iron which results from it) is that which is generally employed for its production.

Means of obviating this difficulty.

"To obviate this difficulty, and to avoid these disadvantages, it appears desirable to introduce between the blast furnace and the puddling furnace some intermediate process, which, like that of the mazéage practised on the Continent, shall sufficiently decarburise the grey pig iron, (which is always produced most advantageously in the blast furnace,) at a small cost in fuel and labour, and without entailing the enormous waste of the coke refinery, so as to enable it to be treated rapidly and without difficulty in the puddling furnace.

Objection to the coke refinery.

"The great objection to the coke refinery is this, namely, that the decarburation of the crude iron, and the elimination of the oxidable alloys which it contains, cannot be effected in it without extensive oxidation of the iron itself, nor without separation and loss of this oxide, as silicate, in combination both with the silica formed during the operation and accidentally present, and with the silicates of the fuel.

"To fulfil the proper requisites, the process adopted for decarburation ought to be such as to enable it to be effected without this excessive oxidation of the crude iron; the oxide formed ought to be reduced again; and the silica and silicates present ought to be removed as fusible earthy slags by the introduction of lime.

Simple process for the conversion of grey pig iron.

"It appears that this decarburation might be advantageously effected by a very simple and convenient process, in which perfect control could be exercised over the extent to which the operation was carried; namely, in a blast furnace of the nature of the common re-melting cupola used for re-melting pig iron in foundries. By re-melting grey pig iron in a furnace of this nature, either alone or along with minerals containing nearly pure oxides of iron, the decarburation of the metal would be readily accomplished, the oxides melted with it would be reduced to the metallic state, while the silicates of the fuel, with the silica, alumina, and other easily oxidable alloys eliminated from the crude iron, would be separated in the form of fusible earthy slags.

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"The iron decarburised in a blast furnace of this description should be charged in its melted state into the common boiling furnace. By such a combination of the two classes of furnace, the conversion of crude iron would undoubtedly be effected with more economy of fuel, reduced loss of iron, together with greater rapidity and regularity in the operation."

The mechanical operations for the manufacture of iron and steel are briefly treated, and the whole is summed up in the following remarks:—

"The principal mechanical agents in these operations are the hammer and the rolls. It is only by a proper combination of both of these agents, that all the requisite qualities in well-manufactured iron can be obtained. In this country latterly there has been a tendency to supersede the use of the hammer by that of the rolls in effecting every class of operations in this manufacture. This is practicable in the production of small sizes of iron, in which the bulk is small as compared with the immense mechanical power under command, but it is not practicable with iron of large sizes, in which soundness is requisite. Soundness in rails, large bars, plates, and thick sheet iron, cannot be obtained without the use of the hammer; nevertheless, its use is almost discarded for these purposes in this country."

Superiority of Great Britain.

The following remarks on the Paris Exposition, and on the comparative merits of the iron industry of Great Britain in reference to that of other countries will be appreciated by those who desire to maintain their superiority, as well as by those who are more immediately interested in this important branch of industry. The observations of our author evidently show that, although we are greatly in advance of other countries in the extent of our metallic productions we are, in many cases, behind them in quality. In the manufacture of steel, in rolling plates and bars, and stamping "uses" and other articles which require ductility and strength, our Continental neighbours are not behind the best performances of this country, and in many instances they are considerably in advance.

Superiority of foreigners.

The manufacturers of France and Germany have displayed in their productions of iron and steel, a degree of knowledge and skill not unworthy of imitation by our own. In proof of the progress which has been made in every department of industry, amongst the different nations of Europe, take our author's closing remarks:—

Exhibitions of metallurgical products.

"To render exhibitions of metallurgical products complete, they ought to comprise the minerals in their raw state, the fuel, the products in each stage of manufacture, the residual matters, and the metal in its finished state. The specimens in this state ought to display the quality of the article, to illustrate processes of manufacture, and to show its fitness for the various purposes for which it is applied. The selling price at the place of manufacture of the article exhibited ought in all cases to be affixed to it."

Exposition of iron industry in the Paris Exhibition.

"The expositions of the iron industry in the French, Prussian, and Belgian departments, were in many cases complete in these respects, with the exception of the element of price. The British department was extremely incomplete. Even the feature of price, in which, if not in quality, a degree of superiority might have been established, was entirely neglected.

French department.

"The French department did not fully represent the iron-producing industry of that country. The principal exhibitors were Boigues, Rambourg, and Co., of Fourchambault; the Company of the Loire and the Ardèche at La Voulte; the Company of the Aveyron at Decazeville; Dupont and Co., of Ars-sur-Moselle; Jackson, Petin, and Co., of Vierzon and Rive de Gier; the Company of Audincourt (for charcoal iron); the Company of Montataire; the Company of Denain and Anzin; and Schneider and Co., of Creuzot.

Machinery.

"The chief features of the expositions presented by these Companies were the general possession of machinery of a very powerful class, the perfection of the mechanical operations as evinced by the soundness and finish of the specimens shown, and the high quality of the iron itself. Another striking feature among these expositions was the position in which the manufacture of steel is taking in foreign metallurgy, not as an exceptional product, but as one of the numerous conditions in which iron can be applied to the arts.

High quality of the iron steel.

Rolling mill.

"The attention now paid abroad to the possession of machinery capable of working iron in the largest masses with facility, and the engineering skill applied to perfecting this machinery, was, among other evidence, shown in the French department by the rolling mill, fulfilling the important desideratum of rolling

heavy iron in two contrary directions without reversing the machinery, with its connected travelling carriages, designed by M. Cabrol, the director of the Decazeville ironworks, working drawings of which were shown.

French boiler plates.

"The quality of French boiler plates was well shown by the remarkable specimens of forging out of the plate, of flanges and other connexions required for tubular and locomotive boilers, without the least fracture in the metal, and without necessity for rivetting in any case. The dimensions of the boiler plates and heavy sheet iron were at least equal to those in the English department. The double T iron exhibited was up to twelve inches in vertical section, and the angle iron to seven inches on each flange. Locomotive wheel tyres, rolled without welding, were exhibited both in the French and Prussian departments.

Double T and angle iron.

Belgian department.

"The Belgian department contained numerous specimens of well-finished boiler-plate and sheet iron of large dimensions, from the works of Couillet, Grivegnée, Ougrée, Schlessin, Seraing, and many others. The most remarkable expositions in this department were, however, those of sheet-iron shown by Remaele and Co., of Lanheid, and by Delloye and Co., of Huy; and of steel resulting from the refining of puddle steel, shown by J. Cockerill and Co., of Seraing. Both of these latter expositions were well worthy the attention of British manufacturers.

Prussian department.

"The Westphalian and Rhine provinces of Prussia were well represented by Jacobi, Haniel, and Huyssen, of Ruhrort; by the Company of the Phœnix, of Eschweiler; by Boing, Rhör, and Co., Limburg-sur-Lenne; by the Company of Dillingen, near Sarrelouis; by the Company of Hörde; by the Royal Foundry of Lohe, near Siegen; and especially in their important steel industry by Krupp and Co., of Essen. There were numerous other exposants from Prussia in this department, some of them from Silesia. The above expositions were, however, those containing the most important objects. The boiler plates and sheet iron shown by Jacobi, Haniel, and Huyssen, were very well finished; one plate was the largest and heaviest exhibited. Its dimensions were 24 feet by 5 feet, sheared. Its weight was 2,500 lbs. The Phœnix Company, of Eschweiler, displayed the heaviest rolled bar. This bar was 10½ inches diameter by 23 feet 6 inches long. It weighed 3⅛ tons. These specimens were remarkable as evidences of the character of the machinery now erecting at Continental works. The expositions of these two houses presented numerous other examples of their manufacture, and complete series of the ores, fuel, fluxes, and products in the various stages of progress; the whole were also arranged in such manner as to enable them to be closely inspected. These features of completeness and good arrangement were prominent throughout the whole of the Prussian metallurgical department. In this point of view Great Britain presented a very unfavourable contrast.

Boiler plates.

Series of ores, fluxes, &c.

Messrs. Krupp's steel.

"The remarkable exposition of Krupp and Co., of Essen, in Westphalia, showed the wide range of purposes to which cast steel may be applied with advantage. This house exhibited rolls of large size, axles, piston rods, cranked shafts, and other objects, up to the weight of about 5 tons in this material, proving its applicability to those purposes in which an extreme degree of strength and durability combined with lightness are required. Krupp and Co. are said to use the newly invented puddled-steel largely in the production of their cast steel.

British department.

"The iron industry of Great Britain was neither adequately nor advantageously represented at the Paris Exposition. The display possessed in no respect the features required to place this great manufacture in a prominent point of view.

"A large number of the ironworks of this country did not exhibit, and the specimens displayed by the others were not classified in any manner either with reference to their nature or the locality of their production. The position also in which they were exposed prevented access, for the purpose of examination, to any other than a few of the more bulky objects. The numerous smaller specimens were so placed, that it was impossible to approach them near enough to inspect them properly.

"The quality of the iron exhibited was not shown in any conclusive or advantageous manner, nor were there any specimens displayed proving the application of greater or even of equal mechanical power in the working of iron in this country as compared with others.

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"So far as equality in the iron exhibited was concerned, there can be no doubt that great superiority was manifested at Paris by other countries as compared with Great Britain; and unfortunately there was no attempt made to place prominently in view that point in this great industry in which we are at present unquestionably without rivals, namely, the cost of production. By an unaccountable omission, there were no prices affixed to any of the specimens of iron exhibited in the British department.

Want of vegetable fuel in Great Britain.

"In concluding the present subject, the following reflections appear to present themselves. Great Britain does not possess the resources of vegetable fuel, the use of which in some processes of the iron manufacture produces such valuable results in the quality of the metal so treated, and when its partial employment can be combined with that of mineral fuel, in those other processes in which the latter can be most advantageously applied, enables the best quality of this metal to be obtained coincidently with cheap production; but Great Britain possesses almost inexhaustible supplies of mineral fuel, and of iron ores, (for the most part of good quality,) in immediate contiguity to each other, and these advantages are less generally possessed by other countries engaged in this industry.

"Perhaps the very abundance of the mineral resources which support the iron industry of Great Britain have contributed to produce, somewhat extensively, a slovenly system of manufacture. It is at least certain that in this country an inferior quality of iron, badly smelted, wastefully converted, and carelessly manufactured, is often produced when a superior quality might be obtained at no higher cost than that which is inferior.

"It appears desirable, therefore, with reference to our future success in this department of industry, to recognize clearly, that we have no exclusive monopoly of the sources of production, and that the progress of material civilisation is facilitating the means of transport, and removing the natural difficulties interposed to this manufacture in other countries, while their industrial energies are receiving, constantly, rapid development.

"It appears, therefore, highly important that we should prepare ourselves by every means for the industrial rivalry which awaits us; and the question arises, whether, in this country, we neglect any available means for this purpose? There can be no doubt that the industrial energies of foreign countries are directed generally by very accurate scientific knowledge, and in no department in a higher degree than in the manufacture of iron. It can only be by the diffusion of this scientific knowledge, more completely than has hitherto been the case, among our industrial population, and by its combination with that energy and practical knowledge which have hitherto directed them, that we can expect to maintain our present position as the chief manufacturing country in the world."

APPENDIX No. 2.

INTRODUCTORY REMARKS TO THE REPORTS AND LABOURS OF THE JURY, CLASS VI.

THE multifarious and widely extended labours of the Jurors of this Class will be a sufficient excuse for a few introductory remarks on the different sections into which they were divided. Before, however, adverting to these divisions, it may not be inappropriate to notice a few of the more prominent features of the Paris Universal Exhibition as compared with others that have preceded it. The first exhibition which was recognized as a national institution was held in France in 1798, and again in several subsequent years, but it was not until 1849 and 1850 that a great International Exhibition was thought of. Exhibitions of machinery, raw material, and the products of manufacture have been held in different localities to a limited extent, but it was reserved for the Great Exhibition of 1851 to show forth to the world the products and industrial developments of every country, upon a scale commensurate with the importance of the undertaking. All nations were invited to forward samples and specimens of their industrial pursuits, and such was the ardour, both of the Governments and the people of every country, to contribute, that a collection was formed unequalled in splendour and extent by anything which had ever been brought together before. Acting upon this example, the French Government, with unbounded liberality, last year reproduced the Exhibition of 1851, and collected within the walls of the Palais de l'Industrie, the B aux Arts, and the Annexe, one of the most splendid collections that can possibly be conceived. The Paris Exhibition differs from that which was held in London, so far as relates to the facilities afforded to exhibitors to dispose of their articles at a fair market price, and thus to give an additional stimulus to them in bringing forward their contributions for sale as well as for exhibition. This judicious arrangement had the desired effect, and subsequent measures adopted by Prince Napoleon and the Imperial Commission, in order to afford time and space for the display of every article of manufacture, contributed in no small degree to ensure the success of the undertaking.

Prominent features of the Paris Exposition compared with that of 1851.

In this widely extended Exhibition, the Jury of Class VI., in the exercise of their duties, found it necessary, in order to ensure a careful examination of the numerous machines and articles contained in the catalogue, to appoint examiners to each section; and as these sections contained a great variety of articles of different kinds and descriptions, it became necessary to select persons acquainted with the uses and application of the articles on which they had to adjudicate. In this selection the President and Vice-President were fortunate in having at their command the services of the following Members of the Jury, to whom was entrusted the examination of the articles in their respective sections, as under:—

Labours of Class VI.

First: Metallurgic machines, machinery used in building, and apparatus for workshops.—M. Polonçeau, assisted by the President, Vice-President, and Commander Giulio.

Sections into which Class VI. was divided.

Second: Mining machinery and other sundry articles.—M. Phillips and M. Bialon.

Third: Hydraulic machines, corn-mills, &c.—M. Hervé Mangon, assisted by the President and Vice-President.

Fourth: Apparatus for workshops and mechanical contrivances.—M. Gouin and M. Clapeyron.

Fifth: Agricultural implements and machinery.—M. Moll, assisted by the President and Vice-President.

Sixth: Machines for the manufacture of small articles in metal.—M. Corridi and the Chevalier de Burgh.

Mr. Fairbairn on Machinery in General.

Seventh: Machines for printing and dyeing.—M. Holm, assisted by the President, Vice-President, and Mr. Bialon.

In treating of these separate divisions it will not be necessary to enter into detail, as that duty has already been performed by the gentlemen whose names are at the head of the sectional reports. What is here proposed is to offer a general outline of the productions illustrative of the varied forms and appliances of the machines which in this department came under the consideration of the Jury. Most of those machines were executed with great precision, and contained the elements of a healthy progression in almost every department of mechanical construction. The ingenious contrivances and varied forms and conditions of the different machines are highly creditable to the constructors, and whether they are considered in relation to the quality of the workmanship, or their application to specific objects of manufacture, they are equally commendable.

Progress in every department of industrial art.

Tools for workshops.

In the article of tools for workshops, such as turning, boring, planing, and slotting machines, it is only necessary to refer to M. Polonceau's Report, to be convinced of the progress that is making in that department of mechanical development.

The contrivances of Whitworth for iron, and of Graffenstaden for wood, are striking proofs of the onward progress of mechanical science; and adding to these the saws of M. Norman, of Havre, the flexible and endless saw, together with the timber-bending machine of Mr. Blanshard, of New York, there are marked evidences of the changes which are taking place in the substitution of the automaton machine for the human hand. The exactitude and mathematical accuracy of Whitworth's constructions, the cutting, boring, morticing and tenoning of the self-actors of Graffenstaden, and the square, oblique, and other forms produced by the saws of Norman, are all of them indications of mechanical combinations of a high order, and are the strongest proofs of the advantages to be derived from the Exhibition.

Mining machinery.

Amongst the numerous mechanical and engineering improvements that have been going forward for the last half century, those which apply to the operations of the miner have not been neglected, and this becomes the more strikingly apparent by a glance at the different contrivances, as given in the Report of M. Phillips. In this department of practical science the health and safety of the miner has not been lost sight of among the numerous projects here exhibited for ventilation, and for boring, sinking, and raising of the mineral products. For parachutes to prevent accidents in shafts there are not less than five different projects, some of them well contrived, and most of them in general use. Similar apparatuses to those shown at the Exhibition are now extensively used at the mining districts of England and Scotland, with greatly increased security to the miner in his descent and ascent from the pit, and with increased economy to the proprietors of the works. Another description of machinery recently introduced are the coal-washing machines. These machines are of great value in purifying the coal from foreign ingredients, removing the admixtures of slate and earthy matter, and preparing it for the blast furnace, where the impurities are considered injurious.

Among other miscellaneous articles included in this section, Mr. Phillips found an ingenious machine for compressing, folding, and finishing chocolate ready for the market. It is founded upon the principle of the machines exhibited at the London Exhibition of 1851 for the manufacture of envelopes, and certainly the projector, as well as the maker of the machine, has done full justice to its production as well as to the utility of its application.

Corn-mills, &c.

The new system of corn-mills, as investigated by M. Mangon, has been generally adopted in France, and in more than one instance it has been introduced into England. In the latter kingdom it has not, however, made much progress, as the mode of driving the millstones by gearing (toothed-wheels) has the preference over the French system by straps. It is found desirable in England to place the millstones in a line along the side walls of the building; this arrangement is found convenient, as the whole of the mill is left open in the centre for stowage.

Hydraulic machines.

The high price of coal, and the subsequent difficulty of employing steam successfully, in the interior of France and most other Continental districts, has caused great improvements in hydraulic machinery and the application of water. The turbine, on the principle of Poncelet, has to a great extent supplanted the cumbrous water-wheel, and it not unfrequently happens that a single pair of stones is driven by a small turbine acting upon and attached to the lower part of the spindle. At other times as many as six or eight pairs of stones, similar to some of the mills of M. Darley, are driven by a single turbine. In this arrangement the turbine gives motion to a vertical shaft, on which is fixed a large horizontal drum, and that again gives motion by straps to the millstone spindle by a tightening pulley to increase or diminish the tension. This altogether is a bulky and somewhat complex operation, but it is much liked in France, and the construction is successfully pursued by Messrs. Feray, of Essonne, near Paris.

In this department of the constructive arts will be found several other clever contrivances for hand-mills, and the machinery for cleaning wheat and dressing the flour, all of which are ably described in M. Mangon's Report.

Mechanical contrivances and apparatus for workshops.

Mechanical contrivances and apparatus for workshops is a wide subject, and comprises a large class of instruments and machines, entrusted to the consideration of M. Gouin and M. Clapeyron. To these gentlemen the community is indebted for a Report on steam and tilt hammers, including such other apparatus as is used in foundries, forges, &c.

A great variety of these engines were exhibited, many of them of first-rate construction, and greatly admired for precision of action and the facilities which they present for the manufacture of "uses" from the forge. On consulting M. Gouin's Report it will be observed that not less than 10 to 12 hammers and tilts came under the cognizance of the Jury for adjudication, and that the efficiency and simplicity of some of the constructions were highly creditable to the mechanical skill of the age. For the details of these constructions reference may be made to M. Gouin and M. Clapeyron's Report.

Agricultural machinery.

On the subject of agricultural machinery a wide field for improvement presents itself, and I may safely affirm that in this department of mechanical science the whole of Europe and America are in a state of transition. The London Exhibition of 1851, and agricultural meetings in England and Scotland, present enlarged samples of produce and new improvements in machines. The International Exhibition was not behind its predecessors in this respect, as may be seen by the Report of M. Moll. To that Report reference may be made for detailed descriptions, and it will be seen from the variety of forms and contrivances given in the list of reaping machines, thrashing machines, and winnowing machines, that the agricultural public are alive to improvement, and that a desire is prevalent among that class to avail themselves of the introduction of machinery into the operations of the farm, and the consequent advantages which the change would effect in the saving of labour in almost every department of industry attached to the preparation of the produce of the land.

The introduction of reaping and thrashing by machinery are of themselves indications of progress, and notwithstanding the difficulties which remain to be encountered in the application of an improved mechanism to the operations of agriculturists, there appears to be no reason to doubt the certainty of a still onward progression, and that the time is not far distant when the plough itself may become a machine of greatly increased utility and greatly increased economy in the preparation and cultivation of the soil.

In a report on the subject of the experimental trials of the reaping machines at Trappe, it is stated that, in order to render machine culture available, it is essential not to trust entirely to the machine, however ingeniously contrived, but to prepare the land for its introduction, and thus enable the engineer to apply his skill with certainty and effect.

What is advantageous for reaping machines will be equally beneficial for the plough, and whenever the new system comes into operation, whether by steam or any other motive power, it will be found essential that the farmer should co-operate with the engineer in all the changes to produce an improved and more effective system of culture.

Mr. Fairbairn on Machinery in general.

In this brief notice it is not necessary to show how these improvements are to be attained; suffice it to observe that the present exhibitions give indications, not only of what has been done, but what may yet be accomplished by indomitable perseverance in the right direction; and there appears no reason to doubt that the same exercise of skill and the same energy of thought will hand down to posterity a series of improvements not unworthy of an age that has witnessed in numerous instances the subjugation of matter to the imperishable domination of mind.

Indications of what may yet be accomplished.

Machines for the manufacture of small articles in metal.

To Professor Corridi, of Turin, and the Chevalier de Burgh, of Vienna, were entrusted the investigation of the class of tools and machines intended for the manufacture of small articles. These objects were numerous and interesting, and the great ingenuity displayed by the contributors was highly creditable to their inventive powers. It would be a waste of time, in the face of Professor Corridi and the Chevalier's Report, to enter into any discussion on the merits of these machines: most of them were skilfully constructed, some of them self-acting, and others effecting a combination of movements adapted in almost every form as a powerful auxiliary to the labour of the human hand. These machines afford in most instances great facilities for construction, they increase and multiply to a great extent the article manufactured: the machine for the manufacture of *hooks and eyes* is one of that description. In its operations it is as near as possible self-acting, and whether viewed as a contrivance adapted to a particular purpose, or considered as a well-constructed piece of mechanism, it is equally effective, and may safely be looked upon as one of those productions that does great credit to the inventor and to the country to which it belongs. These machines are applicable to a variety of purposes, and most of them have been considered worthy of the careful consideration of the Jury.

Typographic and lithographic machines.

Improvements in typographic and lithographic machines are of such vast importance to the extension and maintenance of civilized existence as to render every improvement and every new development a subject of deep interest to the public. The art of printing, when viewed in the light of the promulgator and preserver of all other arts, cannot be considered otherwise than as one of the very first order in the category of useful inventions. It is one on which the existence of civilization and human progress depends, and it comes before the public in a form peculiarly attractive when considered in relation to the art as it existed fifty years ago and what it is now.

In London the newspaper press gives evidence of what has been done and what may yet be accomplished in the resources of an active progress; and referring to the printing of "The Times," where upwards of 50,000 impressions are taken within the short period of a few hours, it ceases to be a wonder that some of the machines exhibited in the Annexe should throw off from 6,000 to 8,000 impressions in one hour. In this section it will, however, be seen from the Report of Mr. Holm, that the contributions of machinery calculated to facilitate and improve the art of printing are both numerous and attractive. Where so much has been done on all sides, it would be invidious to select in a general notice any individual or particular establishment for distinction beyond what has been already done by the decision of the Jury. One very important improvement in the setting and distribution of type, by a mechanical compositor, deserves especial notice. Without going into detail, the mechanical distributor of Mr. Sörensen, of Copenhagen, appears to be one of the happiest essays in the way of alphabetical arrangement and composition that has taken place since the introduction of the art of printing. The skill and intelligence displayed in the arrangement and design of the mechanism of this machine is certainly of the highest order, and the exactitude of the construction, and the harmony of the parts, render it one of the first and most successful machines of the kind that has yet been produced. On examination it is found to effect three objects: first, alphabetic classification of the type; second, the distribution of the letters required in the formation of a word or sentence; and, lastly, in the function or power of consecutive arrangement in constructing the words or sentences so prepared into lines. These properties of the machine appeared to be of great importance, inasmuch as the compositor can sit in front of the instrument, and effect the composition with a facility that it is difficult to appreciate. In this

Mechanical type compositor.

operation the compositor has only to stroke out of their respective grooves the letters required to form the words in the MS., and this is effected in nearly the same way as the notes of a musical performance would be sounded on the pianoforte.

It is to such inventions and such discoveries as those alluded to above that the present as well as future generations are indebted. They constitute, like the steam-engine and the electric telegraph, the real value of the changes which progressively make their appearance in the useful arts, and assuredly nothing can be more acceptable or more interesting to the intelligence of a nation than a saving of labour when accompanied with increased facilities in the art of printing.

Progress of the art of printing.

From this description and the Report of M. Holm it is evident that the art of printing keeps pace with the improvements in other arts. Several splendid specimens of machines are to be found in the Exhibition, and much has been done in France since the English Exhibition of 1851 for the improvement and more perfect construction of the machinery connected with this important process. The same cannot be said of the lithographic machinery. It has not made the same progress in improvement as the letter-press printing; and although several specimens of machines have been produced, they are to every appearance neither so effective nor so well constructed as those for typography.

Reports of the Juries.

The foregoing remarks are not intended to supersede but to direct attention to the Reports;* in these will be found descriptions explanatory of the uses and appliances of the different tools and machines entered in the catalogue of Class VI. of the Exhibition. They constitute a large collection, which, although varied in character and design, have nevertheless undergone careful examination, both as regards novelty of design, superiority of construction, and the requirements to be obtained by an improved and greatly increased production of their respective products. These objects have to a greater or lesser extent been obtained; and the Jury, in the exercise of an onerous duty, have not hesitated to pronounce to the best of their judgment an honest and an impartial verdict.

* These remarks apply to the French Edition of the Reports of Class VI.

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Appendix No. 3.

Since the article on iron ores was written I have had an opportunity of consulting the Memoirs of the Geological Survey of Great Britain, published by the Museum of Practical Geology, in which the following returns of the produce of crude iron, exhibit the total quantity smelted in each district of Great Britain in 1854. It will be observed that they do not widely differ from the returns given by Mr. Blackwell, and assuming the same rate of increase to be going on as during the previous years, it will not be too much to estimate the production of 1856 at 3,100,000 tons.

Total Produce of Pig Iron in Great Britain in 1854.

	Tons.	Tons.
England :—		
Northumberland, Durham, and North Yorkshire	275,000	
Cumberland and Lancashire	20,000	
Yorkshire	73,444	
Derbyshire	127,500	
Staffordshire	847,600	
Shropshire	124,800	
Gloucestershire	21,990	
		1,490,334
Wales :—		
Flintshire	32,900	
Glamorganshire and Monmouthshire	750,000	
		782,900
Scotland :—		
Ayrshire	249,600	
Lanarkshire	468,000	
Other counties	79,040	
		796,640
Total		3,069,874

The statistical returns of the production of pig iron are so intimately connected with those of the fuel used in the reduction of the ores, as to suggest an estimate of the total quantity of coal consumed in the manufacture of iron. From the same returns by Mr. Hunt, the Keeper of the Mining Records, we have the following tabulated results of the quantity of coal raised in Great Britain in 1854 :—

Total Coal Produce of the United Kingdom, 1854.

	Tons.	Tons.
England:—		
Northumberland and Durham	15,420,615	
Cumberland	887,000	
Yorkshire	7,260,500	
Derbyshire	2,406,696	
Nottinghamshire	813,474	
Warwickshire	255,000	
Leicestershire	439,000	
Staffordshire and Worcestershire	7,500,000	
Lancashire	9,080,500	
Cheshire	786,500	
Shropshire	1,080,000	
Gloucestershire, Somersetshire, and Devonshire	1,492,366	
		47,421,651

	Tons.	Tons.
Brought forward - -		47,412,651
WALES :—		
Anglesea, Flintshire and Denbighshire - -	1,143,000	
Monmouthshire, Glamorganshire, and Pembrokeshire - - - - -	8,500,000	
		9,643,000
SCOTLAND :—		
Total of all the coal-producing districts - -	7,448,000	
		7,448,000
IRELAND :—		
Total of all the coal-producing districts - -	148,750	
		148,750
Total - - -		64,661,401

On referring to the above table it will be seen that the quantity of coal raised in 1854, was 64,661,401 tons. If we allow three tons of this immense quantity for every ton of iron smelted, and also three tons for the consumption required to convert one half of that quantity of pig into malleable iron, the result is:—

3,069,874	×	3	=	9,209,622
1,534,937	×	3	=	4,604,811
- - -				
- - -				13,814,433

Or 14,000,000 tons, as the annual consumption of coal for the manufacture of iron in Great Britain ; nearly one-fourth of the entire quantity raised.

ON MACHINERY for WOVEN FABRICS.—By the Rev. ROBT. WILLIS, M.A., F.R.S., &c., Vice-President of the Jury for Class VII.

To the Right Hon. the Lord Stanley of Alderley, President of the Board of Trade, &c.

MY LORD,

THE objects for the reception of which the Seventh Class was arranged were intended to have included all kinds of mechanism, tools, or utensils, especially appropriated to the manufacture of woven fabrics, comprehending every process, from the preparatory cleansing of the raw material to the final finish of the products. A large proportion of the articles embraced by this definition are, however, of so coarse a character, so unchangeable in form, or so trifling, as to be inappropriate for exhibition, and therefore rarely find a place in collections of this nature. The actual Exposition was found to consist of objects that fell under one or other of the following groups:—

Objects comprised in Class VII.

1stly. Numerous specimens of the working parts of textile mechanism, such as weavers' reeds, card-clothing, with a few of the machines for making it, bobbins, spindles, and flyers, shuttle-eyes, mails, heckles, gills, rollers, and a variety of other objects of this nature, which usually abound in expositions. Such detached parts are the tools with which the machines do their work, and upon the good quality of which much of its excellence depends; but they should properly be exhibited amongst products, under the same category as the saws, files, and other tools employed by smiths and joiners, for they require the experience of working spinners and weavers to be fairly estimated, and not that of the skilled mechanist, who, although fully capable of judging the machinery which sets these parts in motion, is wholly at a loss to appreciate the merits of the parts themselves.

Accordingly, the Jurors of the Sixth Class, in 1851, and of the Seventh Class in 1855, were alike perplexed with them, and compelled to call in the assistance of persons experienced in the management of the machines in question.

2ndly. Machines for the preparation, spinning, and winding of cotton, flax, and hemp, wool and silk, that is to say, to carry on all the processes required to bring these materials to the state of thread.

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3rdly. Looms and apparatus for the purpose of weaving, or otherwise plaiting and combining the threads thus formed, into all kinds of woven fabrics, and for sewing them together.

4thly. Apparatus for fulling, felting, shearing, and other processes for dressing the fabrics, or for folding and measuring them.

The objects thus enumerated are perhaps those which, of all others, are the least likely to be so presented in a general and universal exhibition, as to enable a just view of their nature, importance, and relative employment in different countries to be obtained. Their unwieldy bulk, great value, and complication, the necessity for showing them in motion, the unwillingness of established manufacturers to lay open their methods or mechanism, and of foreign machine makers to show specimens of articles that are more likely to be employed as patterns than to lead to orders; all these and similar causes, arising from the fact that the machinery in question is connected with the processes of production, instead of being merely a marketable product, will always operate to keep back foreigners from sending a fair share of manufacturing mechanism to a universal exhibition, and will influence, but in a much smaller degree, the native mechanists.

It would be perfectly unjust to say that upon the present occasion Great Britain was proportionably represented in the Seventh Class, although several of the leading machine-makers sent first-rate specimens of their respective works, and accordingly obtained very honourable positions in the list of distinctions.

English Exhibitors.

Of these machines, the most remarkable was the complete series for the preparation, spinning, and weaving of cotton, which was exhibited by Messrs. Platt, of Oldham, in complete action, in the same manner as in the Exhibition of 1851 at London. Messrs. Mason, of Rochdale, also sent numerous specimens of machines for the cotton and woollen series, and a few other British exhibitors furnished one or two machines each. In fact, there are only about seven names in the list of our exhibitors for cotton machines, two for flax machines, one of which, a hackling machine, by Messrs. Combe, of Belfast, attracted great and deserved attention; and two for wool, namely, Messrs. Sykes' machine for cleaning, which obtained a first-class medal, and some machines in Mr. Mason's collection. Messrs. Chadwick and Dickens submitted their silk-reeling machine for spinning silk direct from the cocoon. This process is so utterly

at variance with the principles and methods applied by the French to the treatment of the cocoon, that it proved exceedingly difficult to obtain an unprejudiced examination of it. In fact, experience alone can show to what qualities of silk it is applicable.

No machines were sent from this country for ropemaking, hosiery, bobbin-net, or the like, although, as is well known, we have admirable machines in daily use for all these purposes. British looms, however, were tolerably represented. But of the final processes by which their products are prepared for the market, we had no representations.

I must be allowed, in the next place, to express my regret that it was not until the eve of my departure from Paris, at the close of the labours of the Council of Presidents, that I was honoured by the request that I would draw up a report upon the machinery of the class to which I belonged. My notes had therefore been for the most part confined to the machinery for weaving or otherwise combining threads in textile fabrics, and for sewing, to which my attention had been especially directed as "rapporteur" of that portion of the Class. To this section, therefore, I am compelled to confine the detailed remarks which follow, referring for information relative to the machinery for spinning, &c. to the published reports of the Bradford and Huddersfield chambers of commerce, and to the forthcoming volume of the Reports of the French Juries.

Looms.

In the French department numerous handlooms and their appurtenances were exhibited, many of which possessed considerable novelty and ingenuity; but of these there was not a single English specimen; on the other hand, the English furnished a profusion of power-looms, which were kept in action during the Exhibition, but the French exhibitors had very few, and those were introduced into the Exposition at a late period, as if to supply a blank which had made itself apparent. A very remarkable feature of the management was the laxity of administration, which not only allowed fresh machines to be introduced, during the whole period of the Exhibition, even to the last week, but permitted them to compete for distinctions. Many machines were, indeed, entirely constructed in the building, and some of these were manifestly new and untried inventions, which had been undertaken for the occasion, and which grew up gradually to completion under the eyes of the visitors, passing through the usual accidents of trials, failures, and

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consequent changes of contrivance that usually attend the first realizations of new ideas.

Foremost among the looms were the Jacquards and their accessories. This, a truly French machine in its origin and employment, although it has spread over the industrial world, appears in many respects in a very different form in its native and in its adopted countries. To judge from the machines exhibited, the efforts of French mechanists appear mainly directed to facilitate the operations of the hand weavers, and to increase the intricacy and beauty of the designs to which the machine may be applied, by improving and simplifying the mechanism which governs the patterns, so as to enable it to be extended to combinations of form and colour still richer and more varied than before. On the contrary, the principal efforts of our own mechanists are addressed to such modification of the Jacquard as will best adapt it to power-looms and to the rapidity of working; to the multiplication of products, and to such constructions of the machine as will enable itself to be multiplied for sale. This view was fully corroborated by comparing the manufactured products respectively exhibited by the two countries.

The exact nature of the objects, the attainment of which appeared respectively to interest the mechanists of different regions will be best shown by a short review of the most remarkable of the actual machines exhibited.

Reading and copying.

Messrs. Martinet and Lacaze, of Paris, exhibited a large and complete machine for reading, piercing, and copying the cards of the Jacquard. This was on the known construction of M. Diondonnat, in which the cards are pierced without removing the punches from the machine, but with improvements that dispense with the necessity of reading the ground of the pattern. The lashing being duly applied to the varied parts of the pattern, the punches for the ground are governed by the cylinder of a Jacquard machine placed above the frame, which acts only on those cords that are unaffected by the lashes at each stroke.

A machine for similar purposes by *M. Ryo-Catteau*, was furnished with additional mechanism, by which it became completely self acting when employed for copying a chain of cards, and very nearly self-acting when applied to the piercing of cards for a new design.

Historical models of the Jacquard loom.

M. Marin, of Lyons, exhibited a most instructive series of nine models of looms, on a scale of $\frac{1}{3}$ of reality, showing the origin and gradual development of the loom, termed the

Jacquard, from which, indeed, this curious fact for the history of invention resulted, that M. Jacquard contributed very little to the loom which bears his name. Bouchon, in 1725, employed a band of pierced paper, pressed by a hand bar against a row of horizontal wires, so as to push forward those which happened to lie opposite to the blank spaces, and thus bring loops at the lower extremity of vertical wires in connection with a comb-like rack below; this being then depressed by hand, pulled down the selected wires, and with them the tail cords of the draw loom, to which they were connected. Here, then, we have the leading idea of the Jacquard loom, namely, the employment of paper pierced in correspondence with the design, and applied against the extremities of wires, so as to displace those which correspond to the blank spaces of the paper, and leave those which lie opposite to the holes undisturbed. Falcon, in 1728, substituted the chain of cards on a square prism, as still used, for the continuous band of paper of Bouchon, and placed his horizontal wires in several ranks as at present, thereby obtaining more space. The accomplished Vaucanson, 1746, suppressed altogether the cumbrous tail cords of the draw loom, and made the loom completely self-acting, by placing the pierced paper or card upon the surface of a large pierced cylinder, which travelled back and forward at each stroke, revolving through a small angle by ratchet work. He also invented the rising and falling griff frame, and thus brought the machine to a state very nearly resembling the actual Jacquard. Jacquard himself, a working mechanic of Lyons, was sent to Paris in 1804, on occasion of his invention of a fishing-net loom, and there, being retained for the purpose of repairing the loom of Vaucanson, deposited in the Conservatoire des Arts et Métiers, was induced to attempt still farther improvements. The merit of Jacquard is not, therefore, that of an inventor, but of an experienced workman, who, combining together the best parts of the machines of his predecessors in the same line, succeeds, for the first time, in obtaining an arrangement sufficiently practical to be generally employed.

Professors of the theory of fabrics.

M. Marin, the constructor of these models, which brought so forcibly into evidence these facts hitherto known only to persons conversant with the workshops of Lyons, has raised himself from the position of a common workman to the important office of "Professor of the Theory of Fabrics"* in that city. This is a class of instructors which appears

* Professeur de la Théorie des Fabrications."

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to be peculiar to Lyons, to which it owes much of the perfection of its designs, and to the want of which our deficiency in that respect may greatly be attributed. Their business is not to teach artistic drawing as a branch of fine art, but to teach the connexion of design with the machinery which must be employed to realise it; to explain the entire construction and management of the looms, the mode of mounting and adjusting them, the different tissues or textures of which they are capable; the application of these to the respective parts of a given design, either as grounds or as means of bringing out details with the greatest effect, and, at the same time, with the necessary economy; for contrast and variety of textures in the different details of a woven picture occupy the place of the painter's "handling" in works of fine art.

A design may manifestly be exceedingly beautiful in itself as a work of art, but wholly inapplicable to weaving. No artist, therefore, can be qualified to make a weaver's design which shall combine in itself the beauty of art, applicability to mechanism, and effective results when translated from oil paint or water colour into silk and worsted texture, unless he be familiar with the mechanism of the looms in their infinite variety, with their practical adjustment, and with the characteristic surface effects of the different tissues. Every designer, in short, should be able to put his own design into the loom, and accordingly artists, after having studied in the school of design at Lyons, put themselves in the next place under the instruction of one of these so-called "professors of the theory of fabrics" for six months or more, to learn the application of the design to the machine.

This is the system which has enabled the manufacturers of that city to produce the magnificent and beautiful specimens which were displayed in the galleries of the Paris Exhibition.

M. Meynier of Lyons.

Among the collections of figured silks from Lyons, that of the house of Godemard, Meynier, and Co. was remarkable for the splendour and artistic beauty of the patterns, the bold and novel effects of colour, smoothness of outline, perfect gradations of light and shade, and clear relief of the figures from the ground, resembling rather the work of the embroiderer than the mechanical results of the Jacquard.

These characteristics were obtained by the employment of some important inventions of M. Meynier himself. One of these is an improved method of mounting a Jacquard harness, with supplementary neck-cords and double mails,

by which its capabilities are more than doubled, the development and perfection of large designs facilitated, and half the expense saved in the process of transferring the design to the pasteboard. This process was so highly estimated at Lyons as to induce the Chamber of Commerce of that city, in 1852, after due examination, to purchase the patent right for Lyons alone for 50,000 francs. Another machine by the same gentleman is a brocading shuttle-bar, capable of working a much greater breadth of pattern than those of the ordinary construction, together with a greatly improved mechanism for giving motion to and stopping the shuttle. The "Grande Médaille d'Honneur" was awarded to M. Meynier for these contrivances; also one to MM. Mathevon and Bouvard, of Lyons, not merely for the perfection of their products, but for the spirit of enterprise and liberality with which they had during a long series of years adopted and brought into practice every new improvement or mechanism as it appeared.

MM. Mathevon and Bouvard of Lyons.

M. Ronze, of Lyons, exhibited a well constructed but complex Jacquard frame, in which the hooks are lifted by a quadruple system of griffs, capable of being thrown in and out of geer, and with other combinations, the effect of which is, that each card is employed for two successive strokes of the shuttle, thus diminishing their number by half, and that by properly changing the combinations of the griffs, seven or eight different textures may be wrought at pleasure by the same chain of cards, and the same pattern be worked upon any one of these as a ground. Other French exhibitors presented machinery for similar objects, or for bringing, at pleasure, any one or more of a group of independent Jacquard frames to bear upon the same harness, thereby combining their respective patterns in various orders. This latter contrivance, by *M. Delporte*, of Roubaix, was, however, confessedly too complex to be employed for any other purpose than the trial and preparation of pattern specimens.

M. Ronze.

A curiously complex, but roughly constructed Jacquard loom was shown by *M. Nicolle*, of Yvetot, in which a second set of leads was combined with the ordinary Jacquard frame in such a manner that at every stroke the number of hooks and leads that were raised were always counter-poised by the descent of an equal number of these supplementary leads. The object of this was to diminish the labour of the workman; but it was evidently unpractical, and the same purpose was much better obtained by the following exhibitors.

M. Nicolle.

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Messrs. Crossley of Newton-moor.

Messrs. Crossley, of Newton Moor, Cheshire, received the Silver Medal for an admirable Jacquard power loom, kept in constant action, which they term a double-lift Jacquard. In this arrangement there are two griffs suspended, one at each end of a lever, so as to rise and fall alternately, and so that at each stroke or pick some leads are rising and some descending. Thus, without increasing the number of leads, the rising and descending leads so nearly balance each other as to leave a very small resistance to be overcome by the moving power. This loom, therefore, can be worked with about the same power as would be required for one for plain calico. It is applicable to fabrics of silk, linen, or cotton, and will work at the rate of 160 strokes per minute.

M. Schramm of Austria.

The Jacquard frames of *M. Schramm*, of Austria, were said to be very generally employed in that country by the weavers; and their construction offered an interesting illustration of the state of manufactures there. The mechanism was wholly constructed in wood, resembling that of a pianoforte. This was for the sake of cheapness and lightness, but would be perfectly inconsistent with rapidity of production. A Jacquard frame with 2,736 needles, was priced at 137 florins, or 274 francs.

Substitution of paper for card in the Jacquard.

One group of machines exhibited evidenced a great desire in France to substitute paper for the pasteboard usually employed for the Jacquard looms; contrivances for this purpose were exhibited in London in 1851, by Messrs. Acklin and Martin, the former obtaining the Prize Medal; but in the present Exposition the number of exhibitors of this kind was much greater, although the object can hardly be said to be realised at present.

The motives for this substitution are partly the great expense of the pasteboard and partly the great size and enormous quantity of cards required for complex designs, which really exclude the Jacquard machine from the manufacture of shawls and such like articles, in which the pattern does not frequently recur, and therefore extends over a great number of warp threads and considerable length of stuff. To enable paper, which is weaker than pasteboard, to be substituted for it, the machinery must be modified so as to reduce the pressure required to push in the needles. This pressure in the ordinary Jacquard, is sufficient to wear holes in the blank spaces of the cards unless they be thick. But, if the resistance of the needles be reduced, they admit, also, of being made on a lighter and smaller scale, so as to bring them closer together, and, in fact, diminish their distance one half. Thus, the size of the paper required for a given

pattern is also greatly diminished. There is also another remark which facilitates the application of paper to complex patterns, namely, that in simple patterns the same figures are continually repeated on the surface of the material, and hence each card of the Jacquard chain returns to receive the pressure of the needles many hundred times in the course of the day's work. But in a complex pattern the design being repeated only at long intervals, each card has to sustain the pressure of the needle so seldom as to enable a weaker material to be substituted for the pasteboard without danger of being worn into holes. As none of the systems proposed, however promising, can be said at present to have the sanction of long experience, which can alone determine their relative merits for practical employment, I shall content myself with referring to the forthcoming Reports of the French Juries for detailed descriptions, and merely state that the principal methods hitherto proposed consist—(1.) In such modifications of the needles and vertical wires as may reduce the pressure of the coiled spring or dispense with it altogether. (2.) In devices to relieve the cards from that pressure of the needles against their blanks, which is occasioned in the ordinary Jacquards, by the fact that the cards strike the needles during the descent of the griffs, before the latter have descended low enough to disengage the hooks of the vertical wires. (3.) In more complex modifications of the Jacquard mechanism, by which the pierced paper, instead of acting immediately upon the needles to push them in, is employed solely to give motion to slender wires, which place the selected needles in a position to receive the push from a strong grating moved by some other part of the machine.

The latter system, the invention of M. Blanchet, of Lyons, in 1838, but since carried out with greatly improved construction by M. Acklin, of Paris, appears to be the only one that can be said to have been actually carried into practice, and that for a peculiar purpose which could evidently not have been effected by the ordinary Jacquard, namely, the manufacture of imitation Cashmire shawls. M. Denierousse, of Paris, exhibited in action one of his looms mounted with a paper Jacquard, on Acklin's patent, and employed for making a portion of a Cashmire shawl. A warp 30 inches wide of 3,200 threads was raised, under a peculiar system, by a Jacquard of 40 needles. The weft was wholly formed from the threads of a series of about 400 little bobbins of eight or ten different colours, which were

M. Denierousse.

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twisted in succession by the fingers of the workwoman under the parcels of threads lifted by the Jacquard. She thus passed slowly from one side of the warp to the other, forming a texture precisely the same as that of the genuine Cashmire, and making, however, only about six-tenths of an inch in length in a day's work of 12 hours. The completion of an entire shawl occupies sometimes 18 months, but can be delivered to the public at a price that is rather more than half that of a genuine Cashmire of the same description. The Jacquard machine not only raises the parcels of threads in the order and number required by the pattern, but, at each lift, indicates to the weaver the colour of the bobbin to be employed, by raising into view a worsted tuft of the same tint.

Power looms.

Under the head of power looms, the English exhibitors, as might be expected, carried off the majority of the rewards. Mr. Parker, of Dundee, obtained the Gold Medal for his excellent sailcloth loom, the same, with some improvements, for which the Council Medal of 1851 was awarded.

Mr. Wood, of Monkhill, exhibited his admirable self-acting carpet loom for weaving Brussels and pile carpets; and Mr. Smith, of Heywood, a collection of four power looms, respectively constructed for weaving brocade or damask, ginghams, fustians, and sailcloth, each distinguished by some ingenious and peculiar dispositions, especially his weft protector, which enables him to throw two shuttles alternately from the same side of the loom without entanglement. Messrs. Todd, of Heywood, exhibited power looms for cottons of singular elegance of construction; and Messrs. Hart, of Coventry, an elaborately finished power loom for ribbons, offering an excellent specimen of the mechanism employed in that city for weaving its characteristic product. Other excellent power looms were sent by English exhibitors.

The absence of this class of machines in the French department formed a remarkable and most instructive contrast to their abundant supply of contrivances relating to figured silk weaving already reviewed. The only French power loom which obtained a medal was furnished by M. Bornèque, a leading maker of Alsace, and offered by him as a specimen of the construction which was found best to answer the requirements of the manufacturers of that district. It was certainly a well constructed machine, of iron, practical, and at the same time light and elegant in appearance; and there

was appended to it an ingeniously contrived shifting shuttle-box, acted upon by a Jacquard chain of wood, each link carrying a single peg, the length of which determined the choice of the shuttle. This latter apparatus was so framed that it could be fixed to nearly any power loom. Other countries furnished specimens of this class of machines of which the two following were the most remarkable.

Messrs. Hartmann, of Chemnitz, exhibited a large power loom for woollen goods, with nine healds and seven shuttles for different colours, with a small Jacquard chain to regulate the movements and selection of these healds and shuttles. This machine contained a number of apparently original arrangements, was admirably well constructed, and was kept in constant action during the Exhibition, performing its functions with perfect regularity.

M. Grassmayer, of Austria, sent a power loom of a good practical construction, with eight healds and three shuttles; the shuttle boxes are shifted after any required number of strokes by pins previously inserted, in the order corresponding to the pattern, in a series of holes on the face of a continually revolving disk at the side of the loom.

Among the appendages for hand looms were several for shifting shuttle boxes. One of the best was that of *M. Blanquet*, of Paris. A revolving shuttle box containing four cells for shuttles was supported at its inner extremity not by an axis but by a large ring fixed on the end of the shuttle race, this left the openings of the cells completely free when the box turned, so as to avoid the chance of entangling their threads. Shifting shuttle boxes.

M. Dumoutier also exhibited a box for four shuttles sliding vertically, but having a simple system of stops which enabled the weaver, by pulling the proper cord, to bring the box at pleasure at once to the position required for any one of the colours. *M. Beau* had a somewhat similar device for the same object.

M. Julien exhibited a "battant brocheur" for hand looms, or batten with spotting shuttles, of a very simple construction, which admitted of working the shuttles at any point of the breadth of the stuff. M. Julien spotting shuttles.

It was much to be regretted that the electric loom of *Bonelli*, of Turin, the latest novelty in this kind of mechanism, and which had been promised from the beginning of the Exhibition, did only arrive at the latter end, and, in fact, was scarcely in a condition for work within a week of the closing, so that it was not in time to receive the judgment of the members of the Jury. Electric loom.

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Passing over several other subsidiary contrivances of lesser importance relating to weaving,* I will merely mention two looms of considerable originality, working without shuttles in a manner very similar to that exhibited for making fringes by Messrs. Reed, of Derby, in the Exposition of 1851. For looms of this class, the weft, instead of being passed completely through the shed of the warp, which necessitates the use of a detached shuttle, is pushed through in the form of a loop by the end of a bar. The last thread of the warp, being mounted on a shuttle, is then passed through the loop to form the selvage, and the bar drawn back again, carrying with it the weft; a new shed being then opened, the bar is again pushed through as before. It is true that this mode of weaving merely transfers the shuttle from the weft to the outer thread of the warp, but it admits of a bobbin being employed sufficiently large to carry the whole length of this warp thread, so that the weaving is never interrupted to supply the shuttle with a fresh bobbin. It is only adapted to narrow ribbon-like fabrics, but it was applied to the weaving of girths and pieces for slippers in a practical and well constructed power loom exhibited in action by M. Latour, and capable of weaving four pieces simultaneously. The same principle was adopted by M. Durand in a most ingeniously original loom for weaving ribbons, with a continual change of colour in the weft.

Shuttleless looms.

Hosiery frames.

Besides looms, there exist a number of curious and useful textile machines, of which very interesting specimens were abundantly furnished by the French exhibitors, but not by those of other countries. Circular hosiery frames were shown by M. Berthelot, as in the Exposition of 1851, and also by others. M. Poivret, of Troyes, had a novel circular frame for weaving a soft texture, applicable to warm woollen shawls and comforters, or neck-ties (*cachenez*).

Lace frame.

Only one lace frame was shown, but this was a magnificent specimen exhibited by the "Association des Tullistes" of St. Pierre les Calais, for the purpose, as they said, of showing the mechanism with which their workshops and factories are ordinarily provided. It was a self-acting Leaver's machine, driven by steam and with a Jacquard. It wrought 46 pieces of rich lace simultaneously, and had 3,360 bobbin carriages and 216 bars. It was a most beautifully finished piece of mechanism, and highly creditable to the place of its origin, in which every part of the machine had been constructed. In fact, the Jury were, at their own request, furnished with

* Some of these are described in the Reports of the Bradford and Huddersfield Chambers of Commerce.

the names of the different mechanicians by whom respectively the separate organs of the mechanism had been manufactured, the general plan drawn out, and the fitting and finishing completed.

Passementerie.

The French makers of "*passementerie*," of ornamental cords, boot laces, watch-guards, fringes, and plaited fabrics, exhibited many exceedingly ingenious machines, generally in operation, which it would be impossible to describe, but to which it is evident they owe their great superiority in the production of articles of this class. Some of these had already figured at the Exhibition of 1851; but none from English workshops. There was also a large and coarsely constructed machine amongst the articles furnished from the Arsenal at Brest, which was destined to the production of plaited cord, of the kind called patent sash-line in England. This, the invention of M. Reech, deserved examination from its superior simplicity to the noisy plaiting machine universally employed for the making of this class of articles.

Patent sash-line.

Fishing-net loom of M. Pecqueur.

The fishing-net loom of the late M. Pecqueur was also to be seen in the Annexe under two forms. This machine is apparently the only successful one hitherto produced for the production of this article; it is employed in France, and also in Scotland and elsewhere. Some disputes between the representatives of the inventor were assigned as the cause which retarded the completion of a specimen of his large self-acting fishing-net loom which occupied a conspicuous place on the south side of the Annexe. But there was also to be seen in daily operation an elegant and complete form of this engine, worked by a weaver, and employed for the manufacture of fine netting for curtains, window blinds, and the like, or serving as a ground for embroidery. Another machine for this purpose, under the names of Estublié and Bilon, was shewn. This was on a totally different system, and was compact, highly finished, and very ingenious, but not brought to such a state of working perfection as would enable a safe opinion to be given of its future prospects of success.

Pricking machines for embroiderers.

Some very elegant and, to judge by the number of specimens shown, generally employed machines were exhibited, which are designed for the purpose of pricking the lines of embroidery or sempstresses' designs, to enable them to transfer these lines to the material, by rubbing coloured powders through the holes. This pricking, which is a very tedious process when performed by hand, is effected by these instruments with the greatest rapidity and precision. A

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jointed frame carries a needle, which vibrates vertically by means of a foot-wheel and connecting cords passing over pullies. The needle point, when guided at the usual rate of a pen or pencil over the lines of a design will prick from 70 to 80 holes in the inch.

Sewing machines.

One of the most remarkable features of the portion of this Exposition now under review, was the enormous increase of sewing machines compared with those presented in 1851.

In the last mentioned Exhibition, the American department contained a single machine, by Mr. Blodget, and Mr. Judkin showed a somewhat similar one on the English side, but imported from America. A large unpractical contrivance for sewing sacks stood in the French department. The two first were kept in action, but appeared only as novelties and curious specimens of mechanism. Other machines were announced, but not produced.

In 1854, the case was wholly different. Fourteen exhibitors* came provided with sewing machines, and sought and occupied the most conspicuous places. Most of them had their stalls furnished with several different machines all in operation, not shown, as before, as individual novelties but as machines ready for sale, and provided to that effect in great numbers, as if to supply a large and accustomed demand. In short, it appeared as if this implement had sprung into industrial life and taken its place as an established and universally recognized member of the series of manufacturing machines. A closer examination of the facts showed that this was really the case in America, and that the use of the machines was gradually spreading from that country into France, Germany, and England, in all which regions it will probably assume ere long the same prominent position which it does in the United States.

It may be worth while, therefore, to put on record a few facts relating to the history and various constructions of these machines, which the facilities offered by my official position at Paris enabled me to collect. The machine has yet by no means assumed a permanent form; many systems are struggling for the mastery, and time has not determined the remedies for their respective faults. The perfection of the machine is alike retarded by the prejudices of workmen and by speculators in patent rights. Thirty-five patents

* *French*:—Magnin, Dard. J. le Blond, Le Duc. L. Say, Siegl. Latour. *American*:—Singer, Wheeler and Wilson, Grover and Baker, Moore, Backus and Peaslee. *English*:—Thomas. *Canadian*:—Taylor and Dockerill.

for sewing machines granted in 1854 in America* will sufficiently show the eagerness with which the construction of this machine is pursued in that country, and the public interest it excites.

The machines, as they exist at present, naturally fall under four classes, determined by the kind of stitch they produce.

1st Class.

Sewing machines with detached needles.

Under the first class come the machines in which the needle is passed completely through the stuff, as in hand-working. It is so natural, in the first attempts to make an automatic imitation of handy-work, that the imitation should be a slavish one, that we need not be surprised to find the earlier machines contrived to grasp a common needle, push it through the stuff, and pull it out on the other side. The first patent sewing machine was thus arranged by Thomas Stone and James Henderson, in France, 1804. English names, doubtless, but they took no patent in England, and their scheme was abortive. Other patents following the same device have been taken from time to time at long intervals, but it being found that the machine was slower in operation than the hand, this mode of attacking the problem of creating a mechanical stitcher has always proved unsuccessful, except in the form of an embroidering machine†. M. Heilmann exhibited at Paris, in 1834, his admirable machine for this purpose, in which 150, more or less, of needles are made to work simultaneously, and embroider each the same flower or device upon a piece of stuff or silk stretched in a frame, and guided by a pantograph. These needles are simultaneously pushed in on one side the stuff, and then pulled through on the other, and *vice versâ*. But the slowness of the operation is compensated for by the number of needles at work, and it is only in this way that the employment of detached needles has been found capable of economical application to mechanical stitching. This

M. Heilmann's embroidering machine.

* In 1842, only a single patent was taken for a sewing machine in the United States; two in 1843, one in 1844, one in 1846, four in 1849, six in 1850, four in 1851, seven in 1852, six in 1853, and, in 1854, the number suddenly rose to thirty-five. In England about 20 patents to the end of 1854, and 37 patents in France to the same period. Nearly the whole of them are communications from America. Some of them relate to systems which I have not attempted to describe, because they have not stood the test of experience, and had no representatives in the Exposition.

† The patents that followed Stone and Henderson's in 1804, in the employment of a detached needle, were Bean, 1843, and Rogers, 1844, United States, for the production of a running stitch by pushing a needle through a series of plaits crimped upon the edge of the cloth; Greenough, 1842, U.S.; Phelizon, 1850; and Canonge, 1852, France, for sewing with Heilmann's double needle; and Sénéchal, 1849, France, for a machine for whipping or sewing sacks with a common needle, exhibited in the Exposition of 1851.

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needle was ingeniously made with a point at each end and the eye in the middle, to avoid the necessity of turning it after each passage. Heilmann's machine was not successful in France, but was well received at Manchester, and has remained in use to the present time. Mr. *Houldsworth*, of that city, exhibited in constant operation a large specimen of this machine, which formed one of the most attractive objects of the Exposition of 1855. It contained a variety of his own improvements, and obtained for him the First Class Medal. This machine requires the attendance of five workwomen, namely, one to guide the pantograph, one for each of the two needle-carriages, and two to thread the needles.

Houldsworth's embroidering machine.

Barbe Schmitz embroidering machine.

Under the name of *Barbe Schmitz*, of Nantz, was exhibited an ingenious attempt to construct an embroidering machine for the same purposes as Heilmann's, in the simultaneous embroidering of a number of similar flowers or spots upon silk or muslin, but with arrangements for complete automatic action in the pantograph and in the needle-frames. Great ingenuity was shown in the contrivances of this machine, but it was far from being in a working state, and was said to be the second only that had been made. Another claimant to the invention appealed to the Jury, and the First Class Medal was accordingly given to the machine, leaving the question of invention to be settled by the proper court of law.

Work of this description can be now executed with great facility by the sewing machines about to be described. They can only execute one flower at a time, but they work with so much rapidity as fully to compensate for this peculiarity, and with the advantage of a greater variety of pattern.

2nd Class.

Chain stitch sewing machines.

The next stitch applied to sewing machinery was that known to embroiderers as chain-stitch or "crotchet." This is wrought by a so called *crotchet-needle*, which terminates in a hook; the needle is grasped by the opposite end, and the hook pushed through the stuff so as to catch hold of a thread below, and being then withdrawn, brings with it a small loop of the thread, the hook of the needle retaining this loop is then repassed through the stuff at a short distance in advance of the former passage, catches a new loop and is again withdrawn, bringing with it the second loop which thus passes through the first. This process being continually repeated along the stuff, a series of loops are obtained of which every one passes through its predecessor. Such a series is termed a chainstitch, and may be used either to

connect two pieces together, or as an embroidery stitch, for which it is well adapted by its ornamental and braid-like appearance. But its fitness for mechanical sewing is due to the fact that the needle is always grasped by one end, and never passed completely through the stuff. Also, the thread may be supplied from a bobbin of any diameter. On the other hand, in sewing with a detached needle, only short lengths can be employed and the machine must be stopped at short intervals to re-thread the needle. Moreover, the distance to which the needle must be drawn after each passage continually diminishes in length.

The first sewing machine for this stitch was invented by M. Thimonnier, and patented in France, 17 July 1830, and again, with improvements, 5 Aug. 1848, in association with M. Magnin. This machine is the type of all the modern ones. It received, however, no extension in France. M. Magnin sent it for exhibition in 1851 to London, but was prevented by illness from showing it in action. But in the Exposition now under consideration he showed it in operation, and it was found to produce finer and more accurate work than any other machine in competition with it. It worked at the rate of 300 stitches per minute, and in its present state is therefore too slow to compete with the American machines. It is, besides, encumbered with many complicated devices, that, however, adapt it admirably to the purpose of embroidering muslin, silk, or other material. This patent was introduced into England in 1848, and into America in 1849. In which country in the same year, (Feb. 6) Morey and Johnson patented a sewing machine for chain-stitch, in which a needle with an eye near the point, perpendicular to the cloth, was combined with a hooked instrument parallel to the cloth for effecting the same purpose as the crotchet needle, which from its delicacy is uncertain in its action. This patent appears to have been assigned to Mr. Singer, and forms the basis of his chain-stitch machine, which was one of the most attractive objects of the present Exposition. Its construction was remarkable for its excellent workmanship, and for the ingenious devices employed for regulating the tension of the thread, facilitating the management of the cloth, and accelerating the work, which can be carried on without risk of failure at the rate of even 500 stitches per minute. To avoid the risk of unravelling, to which chain stitch is liable when the thread is broken, Mr. Singer has introduced a contrivance by which his machine forms a kind of knot at every eighth stitch. It

3rd Class.

Shuttle stitch sewing machine.

appeared that he possesses a large manufactory of sewing machines of different systems at New York from which already more than 5,000 have issued, and at the rate (in 1855) of from 40 to 50 a week.

The above history has shown that the chain stitch machines were the first that admitted of being successfully employed, that they were invented in France but received no extension, and passed into America, where they now enjoy a fair share of success. But we have now to examine a third class of sewing machines, which is essentially American, and which arose in that country a very few years after Thilmonnier had taken his first patent.

The stitch produced is wrought by two threads, and as it bears in America the name of *mail-bag stitch*, it may be presumed that it was employed by the makers of that article before it was applied to machinery. It is now most commonly termed *shuttle stitch*. In the most usual mechanical arrangement for its production a vertical needle, having the eye very near the point, is constantly supplied by thread from a bobbin, and is carried by a bar which is capable of an up and down motion; the cloth being placed below the needle the latter descends, pierces it, and forms below it a small loop with the thread carried down by its eye; a small shuttle, which has a horizontal motion beneath the cloth, is now caused to pass through this loop, carrying with it its own thread; the needle rises, but the loop is retained by the shuttle thread. The cloth being next advanced through the space of a stitch the needle descends again and a fresh loop is made.

This process being repeated along the line of the seam, it results that the upper thread sends down a loop through each needle hole, and that the lower thread passes through all these loops and thus secures the work. If the stuff be thick, the lower thread is drawn up by the tension of the upper one, so as to form loops which meet those of the upper thread half way. In appearance the seam is not to be distinguished from the right side of the ordinary hand stitch, but is alike on the two sides.

Notwithstanding the objections that are urged against this system by the owners of the chain-stitch machines or other different ones, it was evident, from the greater number of exhibitors of this class of sewing machines, that they are the most in demand. Even those exhibitors who had special machines for chain-stitch or double chain-stitch, such as M. Singer, Messrs. Grover and Baker, and others, found

it necessary to present, in addition, some form of shuttle-stitch machine.

The first machine* for producing this stitch was invented by Walter Hunt, of New York, in 1834. He made one or two, but never succeeded in adapting it to produce good work. It was never patented, but after many attempts was laid aside and forgotten, until Elias Howe, of New York, patented in Sept. 10, 1846, a machine on the same principle, which has turned out to be exceedingly practical.

In fact, until this machine was produced the *public* were in possession of no machine for sewing, and after its appearance, when its success became manifest, numerous other machines in imitation of it, were brought out in America, as, for example, those patented by Lerow and Blodgett, in 1849, by Singer and others. These patentees attempted to defeat Howe's patent by appealing to the earlier abortive invention of Hunt, but were unsuccessful, the final judgment having been given at New York in his favour, after long litigation, in Feb. 22, 1854; and it appears that in consequence nearly all the existing patentees of shuttle-stitch machines have either purchased assignments of Howe's patent or are compelled to pay him a royalty. His own machine, however, soon proved too clumsy for general use, and was rapidly superseded by the improvements of his imitators. Therefore, it never appears in competition, and no specimen was shown at Paris; but there were nine exhibitors of this class of sewing machines of different degrees of merit.

Mr. Seymour, of New York, had one of a strong and simple construction and of less price than the others, which appeared to be practical and durable and well adapted to various materials and work, such as cloth, linen, leather, silk, felt, or wadding, and would work at the rate of 500 stitches per minute.

Mr. Singer, of New York, exhibited one, together with his chain-stitch machine already described, of great elegance and precision of construction, to which he had applied many of his peculiar devices for increasing the rapidity of motion and saving the thread from fracture. According to his advertisements 800 stitches per minute might be obtained

* This information concerning the history of sewing machines in America is derived from the decision of Judge Sprague, of New York (Feb. 22, 1854), on the disputed patent of Howe, and has therefore the authority of a legal document.

Rev. R. Willis on Machinery for Woven Fabrics.

from it, and the superior delicacy and precision of its work was daily evidenced.

Mr. Thomas, of London, the original purchaser of Howe's English patent in 1846, became thereby the first introducer of this American sewing machine into this country.* For many years he kept the use of it in his own hands, employing it in his manufactory of stays, and applying himself to the improvement of it, for which he has taken several patents. The machine which he exhibited at Paris was unfortunately sent at a late period, but was remarkable for the ingeniously simple and direct modes by which the various mechanical organs were set in action, totally differing from those of his competitors, and necessarily contributing essentially to the durability and other good qualities of the machine.

Other exhibitors displayed sewing machines, in which the shuttle, in lieu of travelling back and forwards in a right line or small circular arc, was made to run continually in a circular path. Of these, the most remarkable were the machine exhibited by *M. Dard*, but in reality that of Blodgett and Lerow, the original inventors of this system (patented in America, Oct. 2, 1849); the machine of *M. Le Duc*, of Troyes, ingeniously devised, but too complex for practice; and the highly original and ingenious machine of *Messrs. Wheeler* and *Wilson*, of the United States, patented in 1852 and 1854. This is apparently the most direct and simple in action of all the sewing machines, but is unfortunately uncertain and liable to get out of order in its present state.

The remaining exhibitors of this class presented nothing worthy of remark, being mere imitators of some one of the preceding.

4th Class.

Compound chain-stitch sewing machines.

There exists a fourth class of sewing machines which produce more complex stitches than the preceding. These are formed by sewing with two threads, which mutually interlace each other in chain-stitch, so as to avoid the unravelling to which the simple chain-stitch is subject, and also are intended to meet an objection which is urged against the shuttle-stitch machines on the ground that as the shuttle must be small to enable it to pass through the loop formed by the needle-thread, so the bobbin carried by

* This is the second English patent for a sewing machine. A patent, under the name of Bostwick, had been taken in 1844 for the American machine of Bean and Rogers for a running stitch, mentioned above, but which does not appear to have succeeded in practice.

the shuttle can only contain a moderate length of thread. Thus the operation is stopped at short intervals to supply fresh bobbins to the shuttle.

Several patents have been obtained for compound chain-stitch machines. The two earliest, by Grover and Baker (patented in America, 1851 and 1852), and by Avery (at the latter end of 1852), figured at Paris, and also one by M. Journaux Le Blond, of Paris, with some peculiar arrangements, but otherwise resembling that of Grover and Baker. This last appears to have considerable circulation in New York, and is most ingeniously contrived.

The French patent of Avery's machine was, upon its appearance, immediately purchased by the Government, under the fallacious hope of withdrawing sewing machines from commerce, lest they should injure the working tailors and sempstresses. But the necessities of war compelled them to employ these machines in the construction of military habiliments, the demand for which could not be supplied with sufficient rapidity by hand. A complete manufactory was organized for this purpose, which employed (in October 1855) 1500 workwomen and workmen, and various machines driven by steam, amongst which were two for cutting out, and 75 sewing machines, principally on Avery's construction. They were said to be very difficult to manage.

Sewing machines have also been employed at Vienna for military clothing.

In England, as in France, all the most promising American patents have been re-patented, and the use of the machine appears to be slowly and gradually extending itself. It is doubtless yet in its infancy, but it has acquired so prominent a position and shown itself to be so useful, as to deserve the time and attention of able mechanists. Its imperfections will, therefore, be, if possible gradually removed, and it may take its place in the series of manufacturing mechanism as a most useful agent.

In conclusion, I beg to repeat my conviction of the impossibility of forming a correct opinion of the relative condition or progress of the manufacturing mechanism of different countries from the specimens that are to be found in a Universal Exhibition, because, as I have already endeavoured to explain, so many causes operate upon this peculiar class of machines to keep back important objects, in the absence of which no judgment can be formed. Isolated novelties are doubtless presented, and valuable information

may be obtained by the endeavour to discover the peculiar points to which the attention of inventors are directed for the time being, especially in the country in which the Exhibition is held, and in which many of the causes that tend to withdraw manufacturing mechanism from public display do not operate in the same manner as upon foreigners.

I have the honour to be, &c.

Robert Willis.

On General Metal Work.—By Alfred Tylor, F.G.S., &c.

Mr. Tylor on Metal Work.

To the Right Honourable the Lord Stanley of Alderley, President of the Board of Trade.

My Lord,

In accordance with your instructions, I have the honour to lay before your Lordship the following Report upon Metal Work as shown in the Paris Universal Exhibition. Preliminary Remarks.

The classification of so numerous a collection of objects as those exhibited in Paris during the past year necessarily presented great difficulties; and perhaps no scheme could have been proposed which would have been free from serious defects.

In the first place, there were local inconveniences in the site chosen for the Paris Exposition, no area sufficiently large for one building of adequate size being available in the Champs Elysées, a disadvantage which happily for us did not exist in 1851, in Hyde Park.

There, a single palace of great size and simplicity of form was erected on an open space of ground, in accordance with a well considered and admirably arranged plan, which was rigidly adhered to; the entire ground area of the building was apportioned out into 30 rectangular parts, one for each contributing country, so that a certain well-defined and easily distinguished space was appropriated to each nation for the use of its exhibitors, and no subsequent alterations permitted the encroachment of one State upon the territory of its neighbour.

The gallery was similarly divided, with some trifling exceptions.

At the same time the classification of the objects exhibited was so arranged, that the products of the same kind in each country were always contiguous, thus admitting of convenient comparison with each other.

In Paris, on the contrary, two buildings were originally designed, one to contain the general objects, the other the machinery; to meet the exigencies of the site, they were erected at some little distance from each other; and, in consequence of the unexpected demand for space, on the part of exhibitors, great additions had to be made to the *Annexe* (or last-mentioned building), by increasing its length to 3,500 Exhibition Building in Paris.

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feet, and this being still insufficient, a third erection, the *Rotunde* or *Panorama*, was eventually added, to connect the whole under one roof.

Besides these, and separate from them, a fourth section of the Exposition, of great and varied interest, existed in the collection of sculpture and paintings contained in the *Palais des Beaux Arts.*

Notwithstanding these important changes, the Commission Impériale decided that each nation should retain its share of the principal palace, as originally intended, and that the additional space in the Annexe should be granted for the display of those collections for which there was no other room.

Two colonies of British exhibitors took possession of the two opposite extremities of the Annexe, and were thus separated by a distance of 800 yards from their countrymen in the principal building.

Classification.

Similar cases occurred in accommodating the French and German representatives; and though probably unavoidable under the circumstances, yet the undoubted effect was to subdivide a portion of the collection of each nation much more than was desirable; for example, in Hyde Park, in 1851, a student had to visit thirty parts of the building (viz., one part for each nation exhibiting, and so arranged as in many cases to form one connected suite), to examine fully the articles belonging to the class in which he was interested; but in Paris the subdivisions were much more numerous, and the distances more than doubled. He must, indeed, be very enthusiastic who could steadily pursue his search for special classes of objects, located in nearly a hundred divisions, not only difficult to discover, but everywhere surrounded by other kinds of products so interesting and attractive as irresistibly to distract the attention.

The Commission Impériale—in addition to a classification of objects based upon the materials of which they were composed (a system found to answer admirably in 1851)—established some other divisions which have no doubt great advantages, yet on the other hand tended to introduce a complicated for a simple system of arrangement, and which also very much increased the difficulty of adjudging prizes, never a very satisfactory duty.

As an illustration of this classification, I would take a miscellaneous collection of stoves (the produce of a single manufactory), an important branch of English commerce. These, in 1851, were all catalogued as Hardware, class 22, the name by which they were known in trade.

According to the French rules of classification, these *might* be found catalogued under five or six different classes; for

their *construction* would bring them under class 9, Light, Heat, Electricity; their *use* under class 24, Furniture and House Decoration.

Such as were formed of iron castings, untouched by the chasing tool, might belong to class 16. If decorated with bronze ornaments, the jury of class 17 would be alone authorized to determine the merit of the modelling and chasing. The jury of class 15 would have to report exclusively upon any steel ornaments introduced, and that of class 18 upon their porcelain panels. Could a deputation from the juries of these various sections have made a joint examination of the stoves a most fair and accurate judgment would have been delivered; but unfortunately each jury had to work in forty or fifty localities of the building, and therefore (although officially placed in relation with kindred classes) it became impossible to carry on these joint reports to a sufficient extent. In practice each jury confined itself as much as possible to the articles specified within its duties.

Juries.

From this cause, a collection of objects which, placed under one class, would be worthy of close examination, lost much of its interest when several classes examined it at different times in search of their specialities. Notwithstanding the pains taken, it was found difficult for exhibitors to obtain an interview with the members of even one jury, because the subdivisions of different countries before alluded to, and the references from other classes, compelled visits to so many parts of the building, that a fraction only of time could be devoted to each spot. Sometimes, also, when the jury was ready, the case of goods to be examined was locked up, the exhibitor not in Paris, the key in the hands of an agent whose duties had taken him to some other part of the building, so that the necessary information as to different processes of manufacture was often too deficient to permit a right judgment being formed upon the articles in question.

When an exhibitor ought to have been in communication with several juries, the difficulties of meeting them of course very much increased.

There is also another important fact to be adverted to, that, while in 1851 the British exhibition of hardware was very complete, each branch being well represented by our countrymen, France and Germany, partly on account of the distance and partly from other causes, were comparatively but poorly represented in many points.

In Paris, during the past year, the reverse was the case; and therefore any report upon the progress of the metal trade, based exclusively upon comparison of the articles

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contained in the two Exhibitions, would not be fair to either country.

I should not in any way feel competent to give an opinion upon the state of the metal trade in 1851, from the general character of the observations I then made. It is also right to state that my appointment as juror at Paris was only made on the 28th of July, about 14 days before the jury concluded its work, and that therefore I had no opportunity of hearing a great part of the valuable information brought before the jury by the different members composing it, and by exhibitors.

Under these circumstances, I propose to relinquish the plan generally adopted of commenting upon all the important individual collections, and to treat the subject in a more general manner. I propose to treat—

I. Of the Production of Metals in the different countries of Europe, and in the United States of America. The production of iron will, of course, form the principal matter of this part of the subject.

II. Of Metal Work, dealing chiefly with the processes of manufacture.

The publication of this second part I am compelled, however, for a short time to defer.

PART I.—METALS.

IRON.

Gt. Britain, Iron.

Great Britain.—No one can look over the metal work of the Paris Exhibition without remarking how different the objects sought by foreign manufacturers are to those at which we especially aim.

The varied tastes of different races have to be studied, and those materials have also to be worked up which are with the greatest facility placed at the disposal of the manufacturers of each nation. The products, therefore, of two countries are rarely so identical as to admit of a very close comparison.

A great many peculiarities in national manufactures are due to the system of protective and export duties, which turn trade out of the natural channels, and offer a premium for the use of particular raw materials, which may not be the most suitable.

Even after such systems are given up, custom sanctions the employment of indifferent materials and coarse workmanship which, perhaps, in the same country in a former

generation would not have been tolerated, for the consumer is satisfied with what he has purchased before, and can obtain without trouble, ready to his hand; and the manufacturer who has a stock of goods, and a plant adapted for their production, will not change his plans until forced by the demands of the consumer.

On the other hand, changes in the tastes and requirements of the public can be traced to a scarcity, or extraordinary dearness, of materials formerly prized, occurring when cheaper substances, which would answer similar purposes in an inferior degree, became extremely abundant and accessible—during times when political and social events of great importance engrossed all attention, and turned the thoughts of the purchasers away from minor subjects.

As an illustration:—In no country was ornamental smith's work more appreciated than in England during the last century, as the innumerable specimens of excellent design and workmanship in the houses built in that period amply testify; yet, during the first half of this century, there is probably no country which was satisfied with so low a quality of material, design, and execution of the ironwork connected with building.

This remarkable change has been—we think erroneously—referred exclusively to the high price of Russian and Swedish iron, then in general use for ornamental smith's work. It is true that the Government of Russia imagined that we could not carry on our manufactures without their assistance. They raised the price of iron by degrees, from 70 and 90 copecs per pood, which it was in 1770, up to 200 or 220 copecs for new sable and 250 copecs for the best old sable iron. In the year 1800 the Emperor Paul laid an embargo on all the British ships in his ports, amounting to near 300, accompanied with the measure of taking out their masters and crews, and sending them into confinement in remote places of the interior.

Such an event gave, undoubtedly, a great impetus to the manufacture of English wrought iron, which, from the scarcity of charcoal, was at that time extensively manufactured with pit-coal. This was a comparatively new plan; for it appears from Dud Dudley's "Metallum Martis," published in 1665, and reprinted in 1851, that although that ingenious gentleman commenced his experiments for running iron with pit-coal in 1619, in Worcestershire, yet we find, from page 370 in vol. 44 of the "Philosophical Transactions," that, only in the year 1747, the Rev. Mr. Mason saw at the Coalbrookdale works (then managed by Mr. Ford, who married a Miss Darby) the first successful attempts at manufacturing

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iron with mineral fuel for commercial purposes. Mr. Mason states, "I find that Mr. Ford, from iron ore and coal both got in the same dale, makes iron brittle or tough, as he pleases; there being cannon thus cast so soft as to bear turning like wrought iron." With regard to the manufacture and quality of the iron so produced, Mr. Reynolds, now in his 88th year, has informed me, that in the year 1765, his father (who managed the works at Coalbrookdale during the minority of Abraham and Samuel Darby), took out a patent for puddling iron, the invention having been made by two workmen of the name of Crannage.

Mr. Reynolds states positively that "the wrought iron made at Coalbrookdale was very good, quite tough, and broke with a long bright fibrous fracture; that made by Cort afterwards was quite different." In 1812 evidence was brought before the House of Commons to prove that the iron manufactured according to Mr. Cort's process of puddling was very inferior. Since puddling with coal, however, is now the plan in almost universal use in Europe and America, and by means of which iron very closely approximating to the ordinary qualities of charcoal iron is produced, the inferiority of the product alluded to in 1812 should be attributed rather to the want of skill on the part of one of the manufacturers, or to the substitution of rolling for hammering, another process which was introduced by Cort in 1784, and has gradually spread to all countries where coal is employed for making iron. At the present time a reaction has taken place in England, and hammering has lately been substituted for rolling, in all processes except the last, in some of those works which have been expressly constructed for the manufacture of railway bars in South Wales. It is a curious phase to see the Nasmyth hammer fixed in the place from which Cort's rolls have just been removed.

Although the production of inferior qualities of iron has increased in an enormous ratio, yet there appears to have been a greater demand in England for the finest qualities of iron than in any other country; and far higher prices have been paid here for such material than could have been obtained in any other part of the world. The English manufacturers, therefore, appear to have adapted their production and importation to the principal qualities demanded by the consumer, leaving the supply of the finest iron to be furnished by those foreign countries most favourably situated, both as to the possession of fine ores, and charcoal to smelt them with. This latter subject has been ably alluded to by French writers; and it is well to state that an inspection of the list of prices of Swedish iron, from the year 1765 up to

the present time, has convinced the President of the French School of Mines that the most minute variations in the qualities of the different Swedish marks have been most accurately appreciated in this country. The Dannemora iron, which at the time of G. Jar's visit to Sweden and England —in the middle of the last century—(to report upon the state of the iron and steel manufacture), only sold for 15 per cent. more than the 3rd or 4th class of Swedish irons, has gradually advanced to double the price of these latter marks, which are themselves superior for the purpose of making steel, to any iron found in other countries, with the exception of Russia. Whilst the difference in value between the ordinary and the very best qualities of charcoal iron has increased to this extraordinary extent by gradual advances, continued for more than a century, it appears from the evidence of writers living in countries where the consumption of coke and charcoal is nearly equal, and therefore, where the relative qualities are exactly distinguished and appreciated, the distinction between ordinary coke iron and charcoal iron has gradually become less marked by the improvement in manufacturing the latter. It is, however, better to quote the exact words, from paper 471, vol. 3, " Annales des Mines," 1853 :— Gt. Britain, Iron.

" In effect, the greatest obstacle which the forges of coal had to overcome (commenced at the end of the last century) lay in the objections of consumers to use the new productions. Coke iron was, at first, thought improper for most of those purposes in which charcoal iron had been previously employed.

" But, little by little, the attraction of cheapness excited workmen to modify their habits, and to adapt their processes to the properties and faults of the new material. At the same time, the proprietors of forges have endeavoured to decrease these imperfections, and even to develope certain qualities which were wanting in charcoal iron; and in this respect their success has been so marked that many coke forges do not yield in the total of their qualities to the corresponding products made by charcoal. There remains much to be done; and we must admit (in consequence of the facts observed during the last sixty years), that the difference which still exists, in regard to the quality of products, will go on diminishing, as to quality of products, between the two kinds of factories—in the most cases to the profit of the forges worked with coke."

In the face of this evidence it is impossible to believe that the English manufacturers or smiths made less elaborate and difficult forgings, for ornamental or other purposes, than their predecessors in the last generation, simply because they could

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not get good materials. We would ask—when was cast iron for hydraulic presses ever made to resist such strains as at present? When were boiler plates ever made stronger than at present? It should, therefore, rather be stated that the public, occupied with other subjects, lost their taste for decorative iron work, and declined to pay such sums as would have been necessary for the production of the finest work—the price of which was augmented by the increased standard of wages in England, and the advance in the price of foreign iron; both changes being caused by the wars then being carried on.

It was in this very period that the consumption of the Dannemora iron, which was used for steel, and for which the public were willing to pay advanced prices, steadily increased, notwithstanding the great fall in the price of the low qualities of English iron.

It must be also remembered that the English smiths had to compete with another class of artificers engaged in working cast iron, a material which could be much more quickly shaped into difficult forms than was possible with wrought iron. Cast iron had been employed for the railings of St. Paul's Cathedral in the 17th century, having been manufactured with charcoal in Sussex, but did not come into general use for such purposes until the beginning of this century, when the demand for ornamental wrought iron work almost ceased.

The recent revival of a taste for mediæval forms has again brought the smith's art into favour, and some works of great excellence have been already produced.

It may be well to allude to the statistics of the iron trade of Great Britain, in order to place in a prominent point of view what has been attempted and what has been obtained; and then to endeavour to trace out the different objects which have been aimed at by the iron manufacturers of other countries.

The quantity of pig iron made in Great Britain is as follows:—

	Tons.	
1740	„ 17,350	Scrivener, page 136.
1788	„ 68,300	
1806	„ 258,206	
1825	„ 581,367	
1836	„ 1,000,000	Jury Report, 1851, page 6.
1845	„ 1,396,400	
1850	„ 2,250,000	
1854	„ 3,069,838,	Mining Record, page 78.
1855	„ 3,218,154,	„ „ „ 56.

British iron exported:—

	Tons.	
1796 to 1805, average	29,446	Scrivener, page 137.
1806 to 1808, „	41,593	
1814 „	57,019	
1823 to 1830, „	103,439	
1839 „	269,088	Scrivener, page 318.
1852 „	1,035,884	
1853 „	1,246,482	Board of Trade Returns.
1854 „	1,109,299	

Some statistics of the French iron trade are published in the interesting Jury Report for the Exhibition of 1851, signed by M. Dufrenoy, Inspector of Mines for the French Government (printed by W. Clowes and Son, London). An official annual statement of the mining records of Great Britain is issued by the Treasury, compiled by Robert Hunt, of the English School of Mines, Jermyn Street, and a comparison of the mineral industry of England with that of foreign countries will be found in the "Journal of the Society of Arts," for December 21, 1855, and January 11, 1856, contributed by J. K. Blackwell, engineer and geologist. The history of the iron trade is continued to the year 1854 by H. Scrivener of Liverpool, in a new edition of his well-known work on this subject.

In a short report like the present it is impossible fully to enter into such subjects, and therefore, I would refer those to the above authorities who wish for detailed information.

In analyzing the foregoing table, it will be found that the exports to North America, in consequence of the badness of trade caused by their deficient harvests of 1853 and 1854, have decreased from 640,389 tons of iron exported from Great Britain in 1853, to 519,773 tons in 1853 and 1854. The United States, however, still take nearly half the iron exported from Great Britain.

The falling off in 1854 of our exports, shown by the returns, is not entirely correct, as the amount of iron sent out to the East for military purposes is not enumerated.

Since in 1819, the duty on iron imported into Great Britain was 6*l.* 10*s.* per ton, in 1825 it was reduced to 1*l.* 10*s.* per ton, and in 1845 it was admitted free—it is evident that the greatest progress has been made under the pressure of competition with countries where the industry of iron manufacture has been carried on under the especial care of their Governments, and under the so-called protection of heavy import duties.

That ironmasters as a body have turned their attention to those branches of the trade where the greatest demand existed

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is an undoubted fact, and hardly worth alluding to, were it not stated by some writers that the aim of British ironmasters has been quantity and not quality, as though the manufacturer was in a position to dictate to the consumer what description of iron he should purchase or use.

As regards the foreign trade of England, the high duties levied in the United States and other countries limit the use of iron altogether, whilst the differential duties between different sorts of iron induce the consumption of those qualities that are most favoured by the tariff of each country. Thus the ad valorem duty of 30 per cent. in the United States has given an impetus to the sale of the cheaper irons, whilst the fixed duty of 1*l.* 1*s.* per ton on pig iron in Prussia has promoted the exportation of superior qualities; and consequently, when we find that America takes iron of prices *below* the mean of the entire production of Great Britain, and when Prussia takes iron at prices *above* the mean, in consequence of peculiarities of their tariffs, it seems probable that were the trade to those countries entirely unfettered, their demand would be for iron of the average price and quality used in Great Britain.

The general introduction of iron as a substitute for more expensive materials, for purposes where the strength of the weakest metal is fully sufficient, causes a demand for cheap qualities of iron. There has, consequently, in the last ten years, been a very great increase in this department of the iron trade. On the other hand, there are instances of iron being required better adapted for particular purposes than was previously used. The enormous traffic, of a character particularly destructive to iron rails laid down at stations, junctions, &c., has turned the attention of engineers, and consequently of manufacturers, to the production of railway bars of a quality adapted to such positions; and a very extensive production of such iron at high prices has ensued.

In the same manner, the importance of superior axles, pistons, and tires has been more generally recognized; and, in consequence, a large and lucrative trade has been carried on in Staffordshire, Yorkshire, and Lancashire in this manufacture. The excellent character which the English have gained for their skill in manufacturing these above-named articles has been fully maintained. While so much attention has been paid to the quality of station rails, axles, tires, piston rods, &c., it is to be regretted that more care has not been taken by those interested in railways in securing the best kinds of iron, compatible with a moderate price, for the ordinary rails.

The introduction of heavier locomotives, and trains running

at higher speed, has obliged railway companies to replace the older and light rails with heavier metal, requiring greater instead of less care in manufacture, which we fear has not generally been given, under the pressure of the strong competition, both in price and time, that the British manufacturers have been exposed to. The mode of purchasing has not been the best for the consumer, for it appears that the capability of the contractor to fulfil the obligation he is about to enter into, as far as regards time and price, has generally been the principal point attended to by boards of directors. The question of quality, left to be settled between the contractor and the engineer, has been far too little attended to. Neither on the Continent does it appear that a very satisfactory or uniform system of determining the quality of rails has been established; different engineers having provided such tests as they considered necessary, and which appear to have been of the most opposite character in different localities. For instance, the plan of cutting off a piece of rail, and trying its ductility when heated, has been sometimes adopted on the Continent, where the great number of professional engineers, and of the children of manufacturers, educated in schools and colleges where the science of metallurgy and mining are taught, has concentrated attention on the qualities of iron best suited for working, when heated, into difficult forms, and at the same time raised a great prejudice against any use of wrought iron that would not bear this test. Now it is well known, that although there are some scarce and expensive descriptions of iron that would be perfectly malleable when heated, and yet bear the greatest strain when exposed to pressure and blows while cold, yet there is an abundance of minerals that will produce iron extremely malleable when heated, but which is quite brittle when cold; this is, therefore, termed *cold-short iron*. There is also another equally important class of metal, which, when heated, will not bear the hammer but fly to pieces, and yet, when cold, this same metal will sustain an enormous strain, applied by a steam hammer or by hydraulic pressure; this is termed *red-short iron*.* It is, therefore, evident that if the rail was only to be tried cold

* White iron can be puddled much more rapidly than grey or mottled. The Lowmoor and other Companies, who aim at the finest qualities, use only grey iron. They also break every slab of iron intended for choice work into small pieces, and pick out all the imperfect pieces, paying the workman an enormous price for the best compared with the indifferent. These broken pieces are reheated, hammered, and again broken up, before they are piled for axles, engine-wheel-tires, &c. &c. Each piece of finished work is marked, and can be traced through all its stages of manufacture, so that an account of defective work can be and is kept against each foreman.

We learn that the difference between red-short and cold-short iron was early

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under hydraulic pressure (a frequent test on the Continent), the red-short iron, would appear to surpass the cold-short iron.

In practice, however, the property of resisting the friction of the wheels of the locomotive, and their impact at a great velocity without lamination, is so important, that no accurate judgment could be passed upon the comparative quality of rails, without taking means to ascertain their power of withstanding friction and sudden pressure. No test (except actual work) appears yet to have been established which would determine any property but malleability; and consequently very great errors may have been committed by those who have professed to dogmatize upon the merits of rails.

There appear, therefore, to have been numerous causes at work, tending in one direction, which have induced so many British ironmasters (particularly those making railway bars) to deviate from the plans formerly adopted for the manufacture of wrought iron.

In the first place, the home and foreign demand was so extensive, and so much exceeded the supply, that the time of production became a most important element; and processes

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recognized, by the following extract from Dud Dudley's "Metallum Martis," London, 1665; republished, West Bromwich, March, 1851 :—

"Fourthly, the *Cannock* or *Cannotstone*, which last may wel be so caled (although all the other measures be very good), yet this stone is so sulphurous and terrestrial, not fit to make iron; because the iron thereof made is very redshare, which is that if a workman should draw or forge out a share-mould fit for a plough in that red heat, it would crack, and not be fit for the use of the husbandman's plough or share. I may take occasion here to speak of the nature of coldshare iron, which is so brittle, if made of the grain oare or iron stone would be almost as brittle as some *Regulus Antimonii* made iron; for with one small blow over an anvil, you may break the biggest bar that is, if it be perfect coldshare iron; nay the ploughman often breaks his share-point off, if it be made of coldshare iron. But perfect tough malliable iron will not break feasibly in hot heat or cold, as coldshare wil, or red hot as sulphurious veneriated redshare iron will; but yet tough enough when it is cold; all which aforesaid qualities of iron the authour very well knoweth how to mend their natures, by finning or setting the finery, lesse transhaw, more borrow, which are terms of art, and by altering and pitching the works, and plates, the fore spirit-plat, the tuiron, bottome, back and breast or fore-plate, by the altering of which much may be done; if the work be set transhaw and transiring from the blast, the iron is more coldshare lesse fined, more to the master's profit, lesse profitable to him that makes it into manufacturage, and lesse profitable to him that useth it; but the iron made in a burrow work, becometh more tough and serviceable; yet the nature of all iron stone is to be considered both in the furnace and in the finery; that the sulphurious arceniall and veneriating qualities, which are oftentimes in iron stone, be made to separate, in both the works, from the fixed and fixing bodies of iron, whose fiery quality is such, that he will sooner self calfine than separate from any sulphurious veneriated quality.

"No man, I hope, need be offended at any terms of art; it hath been alwayes lawfull for authours of new arts and inventions, at their own pleasures to give name to their new inventions and arts; every tradesman is allowed it in his mystery."

that would increase the rate of production were naturally sought for, particularly as at the same time they tended to reduce the cost of manufacture. The substitution of rolling for hammering, the use of white pig for grey or mottled iron, the employment of coal for coke in the blast furnaces, are all practices tending to reduce the quality of the iron, whilst increasing the rapidity of manufacture, and diminishing its cost.

Secondly, the manner in which many contracts for wrought iron were given out tended to attract attention rather to price than to quality. It is true that the engineer laid down in his specification certain rules as to the processes of manufacture for railway bars; that is to say, he defined the size of the separate plates or bars which were to be forged and rolled into the rail, and arranged for the appointment of inspectors.* The upper portion, the middle, and the bottom of the rails were sometimes even required by the specification to be of different qualities of iron, causing an unequal contraction and expansion, both in the process of manufacture, and afterwards, when exposed to the severe test of sudden pressure in work. The manufacturer was, therefore, cramped in points in which he ought to have a discretion.

It is no doubt true that there are great difficulties, both in drawing up a specification for manufacturing rails, and also of seeing that these directions are carried out; for the metallurgical processes, performed by workmen *apparently* uneducated, require niceties of manipulation and quick appreciation of distinctions and changes in the metal under operation which have hitherto defied description; the best system and materials being quite unavailing without skilful manipulation.

M. Le Play remarks that ordinary workmen, breaking up slags with a hammer, apparently without the slightest effort,

* How difficult is the inspection, necessary to see how a contract is fulfilled, may be imagined. On a recent visit to some large Welsh iron works, I was informed that a publican, who had failed in business in the neighbouring town, had been appointed at a salary of 30*s.* per week as inspector of the proper carrying out of a large contract for an English Company. This man was continually to be seen in a state of intoxication in the works. Another ironmaster had informed me that he had complained of the inspector sent to look over the execution of a contract, at a salary of 25*s.* per week, on account of this individual being well known in the neighbourhood as earning a livelihood by carrying a hand-organ with white mice. The reply to the complaint was that the Company sent whom they pleased, and they only required a person to do exactly what he was told, and they did not wish him to understand the iron trade.

Two foreign engineers were residing in the same neighbourhood at the time of my visit, watching the completion of a large contract, their salaries being 3*l.* a day. One of them had taken the opportunity of his long stay in South Wales to make drawings and to thoroughly understand the manufacture of iron.

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can distinguish differences which the greatest refinements of chemical analysis can scarcely appreciate.

As an instance of the accuracy attained by practice, he relates that he watched the working of one particular copper furnace at Swansea, and took samples of the slag refuse which was about to be thrown away; he reduced 50 samples to powders, so as to obtain one which should represent the average quality of the refuse from this furnace during sixteen days' smelting. He analysed this portion in the most careful manner, and found the per-centage of copper contained only differed in the proportion of one in 3,000 from that present in a sample which was obtained by reducing to powder specimens derived from 50 pieces taken by chance from the slag yard.

It is obviously impolitic to lay any restrictions on the processes of manufacture, unless it is the intention of the engineer to see them thoroughly carried out.

The object of the engineer to obtain iron of a particular kind is also neutralized by the custom, adopted by boards of directors, of receiving tenders from manufacturers residing in districts in which it would be impossible to produce iron of the most suitable qualities, on account of the absence of the minerals required for its manufacture.

The time is surely arrived for conducting an inquiry into the condition of rails laid down since the introduction of heavy locomotives and frequent trains, with a view to ascertain the facts of the case, and to determine the respective values of the iron of different districts and manufacture. This is highly necessary; for an instance only lately occurred of an order being given for railway bars to a particular manufacturer of known character residing in the neighbourbourhood of the line, because for his own reputation it was thought he would supply a good article; the engineer having informed the Board that it was difficult to determine quality by inspection, or by any sufficient tests.*

Since the commencement of railways the advantage of cheap *versus* dear rails has been continually discussed by

* A great deal of light might be thrown on the properties of cast iron of different kinds, by an inquiry into the condition of the different guns that have been used in the present war. Due reference must be made to their conformation, as it is understood that the iron has withstood much stronger tests when in some particular models than in others; and it is most important that blame should not be given to the metal, when it arises from other and independent causes.

The experiments made at arsenals are never made under the same conditions as in actual service, as in an arsenal they are performed by picked men (closely overlooked), who can, to a great extent, control the results. It has been found necessary at the trials of agricultural implements to have indicators entirely self-acting.

boards of directors, and the relative cost and probable durability of the two descriptions carefully inquired into. Thorneycroft's rails, although twice the price of ordinary Welsh rails, are now being supplied to one of the principal English railways.

Wherever the engineers of railways have required better iron, and been willing to pay the proper price for it, there has been no lack of makers ready to compete for the orders, and supply qualities of metal not to be surpassed. For instance, the Lowmoor boiler plates and tires, Thorneycroft's rails and points for sidings and stations, Geach's patent axles, M'Connell's pistons, rods, &c., are not surpassed on the Continent in quality; and no class of work has yielded a larger profit to those manufacturers who have confined themselves to best quality iron. There has been no lack of best iron for the lock and general ironmongery trades of this country; and Mr. Hobbs, whose opinion is very important (for in his mode of manufacture he applies the most severe tests), has informed me that the Staffordshire charcoal iron he employs has answered his purpose admirably. He is too good a manufacturer to waste his labour in working up bad materials for a trifling saving in his cost, and which would soon destroy his beautiful punches, dies, and cutting machinery.*

There certainly is no excuse for the use of unsuitable qualities of iron in this country, almost every possible variety being attainable; so much so, that even small quantities of bar iron, made in Staffordshire out of argillaceous ore, and termed in the trade *gun iron*, are exported to Prussia and Belgium for the manufacture of small arms, although costing in England 27*l.* per ton; Swedish iron, treated in a peculiar manner by a manufacturer at Linlithgow, so as to adapt it for some engraving purposes (for which it answers better than steel), is used in Manchester, and is also sent to America, although costing 60*l.* per ton.†

* Under these circumstances, it is satisfactory to find that Colonel Colt and Mr. Hobbs, two American manufacturers settled in England, find no difficulty in obtaining the best qualities of metal. For their malleable castings, the Ulverstone charcoal pig iron (value 8*l.* 10s.) is employed. When converted, this will bear forging, and Colonel Colt considers it three-fourths the strength of Lowmoor bar iron.

† This manufacturer (Mr. Hawksworth, of Linlithgow), in a letter, makes the following statement: "The process, as far as I feel at liberty to describe it, is as follows:—I take Swedes iron, and cut it up into small pieces, and then fill a fire clay crucible with these pieces, and by adding certain fluxes I am enabled to draw out the whole of the impurities, and reduce the iron to a perfect liquid state, and thus bring the metal perfectly homogeneous in texture. The time occupied in reducing 70 lbs. of iron is from six and a half to seven hours; and, at all times, the risk of the crucible giving way, and losing the metal, is great.

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I would now just allude to the circumstance that the principal market for Swedish iron has been so long in Yorkshire, that contracts have been made by the Swedish producers with the Sheffield merchants and manufacturers for the entire produce of particular forges.

At the present time, therefore, English merchants having branch houses and agencies in the United States and on the Continent for the sale of their steel, and also having a practical acquaintance with the details of the trade in the valuable irons of Sweden, and also the entire control over some of those marks of iron which have for centuries constituted the material out of which the finest steel has been manufactured, have become the agents for the distribution of Swedish iron to all those countries where the manufacture of superior steel is carried on.

It thus happens that supplies of iron of a far more expensive character than any ever manufactured in France, are actually sent from Sweden to France through the hands of English agents, and invoiced at as much as 34*l.* a ton, notwithstanding a duty of 4*l.* 8*s.* per ton. I should hardly have alluded to these subjects in so marked a manner, had it not been supposed by many who visited the Paris Exhibition, and admired the metal work exhibited by the manufacturers of foreign countries, made out of the finest materials and with the greatest skill, that there was a difficulty of obtaining raw material of equal quality in this country. I may state that with two exceptions, viz., the iron from which puddled steel is made in Rhenish Prussia, and that from which the celebrated * sheet iron of Vouissokogorsk in Russia is fabricated, all the finest as well as the most useful descriptions of iron and steel are to be met with in any reasonable quantity in this country.

One of these exceptions will soon be entirely removed, for at the present time the Lowmoor Company are producing puddled steel from their own argillaceous ores in Yorkshire; and this is now used in Sheffield for the same purposes as that made from the Prussian steel pig. The Ebbw Vale and other Companies have taken grants of mineral concessions in Somersetshire and Devonshire, containing immense

Thus, you will readily see, the price must of necessity be high. British iron becomes brittle and useless under this process; it appears to me not to have sufficient body to withstand the long continued and excessive heat that it must undergo to ensure its reduction."

* The superior surface of the sheet iron exhibited in the French, Belgian, and Prussian departments arose entirely from the skill with which it was rolled, and not from any peculiarity in the iron. In those countries where sheet iron stove pipes are introduced into well-furnished apartments, a demand naturally arises for sheet iron of very smooth surface.

deposits of the spathic iron ore (crystalline carbonate of iron) similar to that used for making the puddled steel, exhibited by Krupp and others in the Prussian department of the Paris Exhibition; in a short time there will, therefore, be an abundant supply of this steel pig, probably at far lower prices than it could be produced for on the Continent; and we may hope that new branches of industry will arise with the introduction of this valuable material, which has been so strangely overlooked.

Before alluding to the characteristics of French metallurgical industry, it is, perhaps, best to take the general summary of the total production of iron in the world, as published by Mr. Blackwell, a gentleman who was formerly an inspector of mines in Great Britain, and who has travelled through many of the iron districts in Europe and America, ("Journal of Society of Arts," Dec. 1855). Mr. Blackwell states that the annual production of pig or crude iron appears, from a careful comparison of different authorities, to be at the present period nearly as follows:—

J. R. Blackwell.		Other Authorities.		
	Tons.		Tons.	
Great Britain . .	3,000,000	R. Hunt .	3,069,838	1854
France	750,000	M. Chevalier .	600,000	1855
United States of America	750,000	Prof. Wilson .	805,000	1853–4
Prussia . . .	300,000		* 430,000	
Austria . . .	250,000			
Belgium . . .	200,000			
Russia	200,000			
Sweden . . .	150,000			
Various German States.	100,000			
Other Countries . .	300,000			
	6,000,000			

If we compare the countries which chiefly produce iron for the last twenty years, we find that Mr. Wœrn states that,

Great Britain	increased in 1850,	244	per cent.
United States	„ „	171	„
France	„ 1846,	141	„
Russia	„ 1849, 1851,	20	„
German Customs Union	„ 1850,	60	„
Austria	„ „	130	„
Belgium	„ „	217	„
Sweden	„ „	51	„
Norway	„ 1841, 1845	62	„

* This is calculated from the returns of iron ore, taking five tons of ore for one of pig iron, which appears to have been the proportion in previous returns.

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The favourable result shown by this table to have been obtained by British industry, in the development of mineral wealth, is undoubtedly due to several causes. The proximity of the iron ores to the mineral fuel, and their occurrence in thickly populated districts—close to the sea, or to navigable rivers or canals—are, no doubt, most important aids to success. The temperate climate of Great Britain, and the remarkable physical power and industry of the labouring population, have in no small degree facilitated progress in occupations which, whether from confinement under ground, or from the excessive heat of the furnace above ground, must require sacrifices of comfort of no ordinary character. The proprietors of the land have aided by letting their lands on a system of royalties, depending for their benefit on the success of the undertaking, instead of requiring the purchase of the freehold or a certain fixed rental. In selecting their tenants, they appear to have given the preference to active intelligent men, who had by saving and industry raised themselves from a lower position, rather than to the system of forming companies of capitalists, to be conducted by less practical men.

There have been, no doubt, inconveniences in such a system; mines have been worked without proper plans, and great losses of life and property have occurred through negligence and incompetence; but a mass of practical knowledge has been obtained by experience (which will enable such errors to be avoided in great measure for the future), such as never could have been accumulated by any *à priori* reasoning; and which, we may hope, may become a solid basis for the application of the true sciences.

Uninteresting as the specimens forwarded to Paris to represent the great industries of iron and coal might appear, yet these trades directly provide subsistence for a twentieth part of the population of Great Britain, and indirectly contribute to the maintenance, to the comforts, and to the luxuries of the whole population.

In contemplating the more attractive exhibition made by those engaged in other occupations, we must, therefore, not forget the important, though different, path in which the British coal and iron masters have laboured. Not only have they, in the last thirty years, raised the production of iron and coal to its present enormous amount, but they have not waited for the aid of Government to provide them with the means of inland communication they require.*

* The first railway was formed by Messrs. Pease, of Darlington, associated with a few other individuals interested in the neighbouring coal mines, and carried out without an Act of Parliament. It was on this occasion that an

The distinction between the ancient and modern system of reducing ores, lies principally in the dimensions of the furnaces, and the greater masses manipulated at the present time. Metallurgy is greatly indebted to the practical mechanic for the means (now available) by steam power of obtaining and moving about large quantities of material with ease and at trifling cost into every position which may be requisite, thus giving a facility for carrying on works on a much larger scale than was formerly practicable. Pure chemistry has yet to be brought to bear upon the *practice* of the metallurgical arts, and it is to be hoped that this duty will be performed by the young chemists, who, having completed their curriculum of studies at the schools and colleges, are now distributed (not as teachers, but as learners) in the iron producing districts. The data they are collecting, the observations they are patiently recording, and the experiments they are watching, we may hope will enable them, at some future period, to add a valuable contribution to those stores of facts which guide the furnace workman in his daily toil, and which we cannot doubt have descended from nations, who having left no written record of their history for our instruction, have yet handed down to us in their tumuli interesting proofs of their metallurgical skill and ingenuity.

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France.—We have now to consider what causes have influenced the commerce in iron in France; and among the most prominent will be found restrictions placed on the development of mineral industries by legislation in favour of landed proprietors. We should naturally expect to find that in a country like France, where the preservation of

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opportunity was offered to George Stephenson to distinguish himself; and having clearly shown his remarkable abilities, he was, by some of the partners in the Stockton and Darlington Railroad, placed at the head of an engineering establishment at Newcastle-upon-Tyne.

The first step in railway works taken by the Durham mineral proprietors was soon after eclipsed by the scheme supported by the great manufacturers and merchants of Lancashire, who subscribed the capital for the Manchester and Liverpool line. This remarkable work was, however, constructed by Stephenson, and the locomotives designed and made by him in the Newcastle manufactory.

In contemplating the finished work, we are too apt to forget the slow stages by which it was attained. It is therefore to be regretted that the particular steam-engine constructed for the first railway (the most splendid instance of English invention of modern times), which gained the prize at the first trial of locomotives, was not exhibited last year in Paris. The "Rocket" is carefully preserved at Stephenson and Co.'s works at Newcastle-upon-Tyne, and will no doubt be forthcoming, should a national collection of the best trophies of English skill be made. It should be remembered that there are other still earlier locomotives in existence, one of which is at the Sheldon works, ten miles west of Darlington. By a little inquiry, some of the steam-engines prior to the time of Boulton and Watt, might be brought to light. It is possible that models of the engines constructed in Scotland by Fulton for the first steam-boat ever made, might also be procured.

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timber is considered one of the most important duties of Government, there are rigid laws as to the quantity of charcoal that might be annually removed from each district for the use of the ironmasters. Such supervision would be evidently necessary to enable the stock of timber to be kept up; for, it appears, that in 1846, 519,991 tons of charcoal were consumed in the manufacture of only 282,683 tons of iron. Regulations for keeping a proper supply of wood are, however, not necessarily an injury to the ironmaster. For instance, in Sweden, where the production of charcoal iron is more than half that of France, similar laws existed for the preservation of forests; but they were accompanied by others which gave to the proprietor of each licensed forge the right of obtaining a sufficient supply of charcoal at a very low price, quite independently of the wishes or consent of the proprietor of that forest. Although these latter regulations have been lately repealed, no forge can be set to work without the sanction of the Mining Board. It is considered in Sweden that forges should be separated a certain number of miles from each other. In France, however, the legislation since the reign of Napoleon I. has been of an exactly contrary character, having the effect of keeping the price of charcoal up to its highest possible point, and treating the manufacture of iron as a secondary occupation, that should by no means interfere with the privileges of the landed interest. This subject has been investigated in a careful manner in the "Journal des Debats," in January of this year (1856), in such language as the following, referring to the year 1814:—

An income was to be created for the remains of the great families returned from the emigration, and restablished in the possession of their forests. TO RAISE THE PRICE OF IRON WAS TO RAISE THE PRICE OF WOOD. One of the first acts of the Government of the Restoration was to augment the duty on iron, then only 35*s.* per ton, and in 1822 it was again raised, so as to bring it to 11*l.* per ton for heavy bars made with coal.

In spite of this tariff, the trade of the iron manufacturer was not so profitable as before; and an inquiry was made by a commission in 1829, by whom it was reported that, while the ore, inclusive of mining expenses, formed only 11 per cent. of the total cost of the iron, the fuel, exclusive of the cutting and carriage, amounted to 39 per cent. Some instances are recorded where, upon the alteration of the tariff, wood rose to three times its former price.

The average value of French iron was above 20*l.* per ton, and of some qualities 24*l.* per ton, showing an excess over that of English of 10*l.* per ton.

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M. Chevalier says, the proprietors of wood (the landowners) received the profits; and there is no exaggeration in the calculation made, that the subsidy paid by the public to the iron manufactory, from 1814 to 1848, in consequence of these duties, amounts to 1,200,000,000 francs, or 48 million pounds sterling. From these statements, which are confirmed by many allusions made by M. Le Play in his works on South Wales, &c., as to the restrictions introduced by the French Government for the supposed benefit of one class, the landowners, and for the very certain injury of all other classes of the population, we cannot but admit the conclusion which has been drawn from the foregoing remarks, viz., that, as a general rule, the iron manufacturers have been the collectors of a tax of 48,000,000*l.* levied upon the public; and that, at least, the producers of charcoal iron have not received any share of this spoil, the whole of which has gone to the landed interest, and to the manufacturers of coke iron. Thus, those who have adopted what is called the "English system" in France (that is, the substitution of coal for charcoal, and the use of refineries, puddling and boiling furnaces, and rolling machinery in the place of hammers), and who have chosen good positions, have made splendid fortunes; those who were ill situated have vegetated, and the public has paid for all. The increase of the manufacture of coke iron is evident from the following tables; but still the whole quantity made does not exceed that turned out by the united efforts of three of the largest English makers, Ebbw Vale Company, Baird and Co., and Guest and Co.*

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* "With regard to the ironstone, France is very rich in the minerals of iron, but, with some exceptions, they are found at places distant from the coal, and as the cost of the iron depends upon the price of the fuel, it is easy to understand that this is one of the principal causes why France is behind other countries, and of Great Britain in particular.

"The quantity of ironstone raised in the year 1847 was 3,413,718 tons, the price at the mine being 2*s.* 2*d.* per ton. In 1848, a year of disturbance, the quantity was not taken, but it was considered to be about equal to the average of the two following years.

				s.	*d.*	
1847	-	3,413,718	-	price	2	2 per ton.
1849	-	1,740,913	-	„	2	9 „
1850	-	1,791,892	-	„	2	10 „
1851	-	1,748,771	-	„	2	11 „
1852	-	2,050,612	-	„	3	0 „

"Thus by the crisis of February 1848, the production, and consequently the consumption of ironstone was diminished one-half, and the mean price was raised, a natural consequence, when it is considered that the preparations in 1847 '*que nous prenons pour une année normale*,' were made for a regular consumption, and when the demand decreased the general expenses necessarily increased."—*Scrivener.*

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The following table, published in the "Comptes Rendus des Travaux des Ingenieurs de France," and also, page 25, Jurors' Report for 1851, gives a tabular view of the proportions of coke and charcoal iron made in France:—

Year.	Quantity of Pig Iron made with Coke.	Quantity of Pig Iron made with Charcoal.	Total.	
	Tons.	*Tons.*	*Tons.*	
1819	2,000	110,500	112,500	Jurors' Report, 1851.
1830	27,103	239,258	266,361	
1840	77,063	270,710	347,773	
1846	269,702	252,683	522,385	
1847			583,054	Scrivener, page 394.
1848			465,626	
1849			408,219	Society of Arts' Journal, April, 1856.
1850			399,800	
1851			439,376	
1852			515,102	
1855	M. Chevalier estimates		600,000	

As might have been expected from the small total of this table, the quantity of iron produced in France has been far less than that really required; and M. Chevalier alludes to the impossibility of obtaining supplies of iron, even at the enormous prices quoted, because the manufacturers preferred to make a small quantity to be sold at a very high price.

With such a temptation in the way of profit, there must have been not only the extortions of the landed interest and the restrictions on the part of Government already alluded to, but also great apathy on the part of the manufacturers, who must have been at one time ignorant of, or unduly prejudiced against, the use of coke iron, which is certainly for foundry purposes equal or superior to what is ordinarily made with charcoal. It is not quite the same, as regards the manufacture of wrought iron; for although wrought iron made with coke answers all ordinary purposes, there is undoubtedly a select class of objects for which iron made with charcoal is desirable. This branch of metallurgy has been brought to great perfection in France, and such an exhibition as that of the Forges d'Audincourt was, indeed, creditable to the skill and ingenuity of the French manufacturers, although against the received notions of political economy. In this case, a company that has for many years led the progress movement in France, exposed specimens of what in England would have been the produce of eight or ten distinct manufactories; there

* The difference between the French and English ton is 35 lbs.

was hardly a specimen there that could be surpassed by that of any other country.

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The sheet iron was the smoothest and most malleable; the girders and sash-bars of most difficult form were unsurpassed: the ether machine, composed of tubes of elliptical form drawn out of the solid, the brass and iron tubes, twelve feet long, made out of round pieces of sheet metal (two or three inches diameter, and a quarter of an inch thick), were certainly marvels of ingenuity and skill in manufacturing; but the jury could not recommend such a system of manufacturing for imitation, because, in the first place, they were informed that the production of many articles exhibited must be given up, or the plans modified, since the goods could not be sold at a remunerative price; and, *secondly*, because it is an objectionable system for one company to lay out its capital in works and plant of kind so different as to require the attention of a great number of superintendents to manage the different trades followed. There requires no argument to show that the successes of modern manufacturers have, in no small degree, arisen from great capital being invested in special plant for producing one class of articles, with the maximum amount of division of labour and minimum of cost.

The interesting exhibitions of metal work contributed by many foreign companies would, in the opinion of our soundest writers on such subjects, indicate an imperfect idea of the true principles of manufacture; and they would praise the practice of those leading firms of the United Kingdom who have gradually given up the fabrication of articles of small demand, and have concentrated their attention to first and second products. Thus, Baird and Co. only manufacture pig iron; the Ebbw Vale Company, and Guest and Co., only railway bars; yet these three firms produce together as much iron annually as the whole of Prussia, and more than any other country, excepting France and the United States of America. Specimens of all the different articles manufactured by these three firms was compressed into a few feet; and, unattractive as they might be to the public, must have read to many a foreign ironmaster the important lesson that the production of iron in the first stages is quite sufficient to employ the capital of any iron company now in existence, however vast may be its resources.

It cannot be said that the want of means of communication between the iron ore districts and those abounding in mineral fuel prevented the early introduction of iron smelted with coke, for Mr. Blackwell states, the great production of charcoal pig iron is in regions in close proximity to some of the

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most important coal fields in France; page 70, "Society of Arts Journal," December 1855.*

Looking at the extensive new works in the great coal field, 80 miles long, which has been opened out in the last ten years in the department of the Pas de Calais, (and which is laid down in a map which will be found at page 252 of the Geological Society's Journal for the present year,) it seems hardly possible to explain the statements which have been published upon official authority respecting the comparative quantities of coal raised in France in 1847 and 1852, since they appear so much smaller than might have been anticipated.

Year.	French Coal raised.	Foreign Coal consumed.	Total.
	Tons (British).	*Tons (British).*	*Tons (British).*
1841	3,370,840	1,619,160	4,980,000
1847	5,010,382	2,501,901	7,512,283
1852	4,782,515	3,033,888	7,816,403
1854		3,123,892	
1855		3,954,056	—

It will be observed, therefore, up to the year 1853,† that the use of foreign coal had increased by upwards of 21 per cent. since 1847, whilst that of French coal had decreased nearly 4½ per cent.

* Mr. Kind, whose system of boring was noticed in the "Mining Journal" of 1855, has recently been busily engaged in boring a new Artesian well in the Avenue Charles X., at the angle of the Avenues St. Cloud and Petit Parc, near Paris, for the purpose of supplying the ornamental lakes of the Bois de Boulogne. An interesting paper has been communicated to the Académie by M. Dumas on the subject, from which it appears that Mr. Kind has undertaken to bore a well 29 inches in diameter, and continue the sinking, if necessary, to the depth of 2,500 ft., and thus obtain a daily supply of 10,000 cubic metres of water, being nearly equal to the volume of water delivered by the Seine through the Pont de la Tournelle at Paris. The boring was commenced on 2nd August last, with a diameter of about 41 inches. For some time, when the operations were through marl and chalk, the average daily progress was 16½ ft.; then, through sand, it was reduced to 8½ to 10 ft.; and now, having reached another stratum of chalk containing boulders, the speed is 5 ft., the depth being already upwards of 980 ft., and by May 1 it is expected that the enormous depth of about 2,360 ft. from surface will be attained, being more than 490 ft. deeper than the Artesian well at Grenelle. M. Dumas gives a detailed account of the process, but as we have before fully described the mode of operation, the repetition is unnecessary. We may remark, however, that the sole motive power is a steam-engine of 24-horse power. M. Dumas was authorized by Mr. Kind to make known to the Geological and Mineralogical Departments of the Académie that, when any stratum appeared particularly interesting to them, he would detach and bring to surface a specimen 20 inches in diameter, and from 3 to 6½ ft. in length, in order to show the real composition of the soil.—*Mining Journal.*

† The returns of coal, &c., raised in France have not been published later than 1852, and therefore the comparison cannot be carried further. This is unfortunate, as the consumption of fuel is one of the best tests of the activity of manufacture.

The following table exhibits the countries from which coal is imported into France:*— MR. TYLOR ON METAL WORK. France, Iron.

	1841.	1852.	1854.
	Tons.	*Tons.*	*Tons.*
Belgium	992,226	2,081,338	2,142,112
Great Britain	429,950	640,740	590,336
Rhenish Provinces	196,502	318,470	391,444
Other Countries	482	127	
Total	1,619,160	3,040,675	3,123,892

As peat has a considerable consumption, it may be as well to state that the annual average quantity raised in France was 468,395 tons, average price 7*s.* 7*d.* per ton.

It is remarkable that, on examining the returns of the iron imported into France in the last year, we should find a higher rate of increase in the importation of iron than of coal. It would be interesting to learn whether this is owing to the demand for metal for war purposes, or whether it is in consequence of the increased consumption of iron for purposes connected with agriculture, which, according to M. Chevalier, is an almost unopened field for commercial enterprise; the average quantity of iron now used in France, on account of its excessive price, being only one-third of what would be employed on an equal acreage in Great Britain.

The iron imported into France, from customs' returns, is as follows:†—

Year.	Pig Iron.	Wrought Iron.	Total.
	Tons.	*Tons.*	*Total.*
1827	7,790	7,130	14,930
1841	26,933	6,070	33,004
1845	55,640	6,980	62,620
1847	85,000	—	—
1854	80,723	7,085	87,808‡
1855	134,219‡	—	—

Of this quantity Belgium, in 1854, supplied five-ninths, England three-ninths, and Sweden and other countries one-ninth.

* These statistics of coal indicate a marked contrast to what has taken place in Great Britain, where it is supposed the production has increased from 34,754,750 tons in 1845 to 64,661,401 tons in 1854.

† In 1854, 42,874 tons of iron were exported from Great Britain to France, according to the official returns published by the English Board of Trade, and this differs from the French figures.

‡ The amounts of cast iron imported into France are given by Mr. Lack as above, but as the wrought iron returns are not yet published, I cannot state the total increase of the importation of iron into France in 1855 over 1854. This

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It may, perhaps, be thought that whilst the English have been occupied in producing great quantities, the French have laid themselves out for producing good qualities, by a more scientific system of manufacture than we have attained to.

It is true that the attention of most of the eminent chemists France has produced has been turned to the improvement of metallurgical processes, and the experiments of Reaumur in 1728, in his essays at the expense of Government to prepare French iron so as to rival the Swedish, are matters of history. The axiom that Reaumur started with was, that France, with its variety of rich minerals, must possess some equal to those found in any other country; and his want of success in producing steel equal to that made in Sheffield from Swedish iron was ascribed by him to his ignorance of the mysterious flux* used by the English. Grignon and Buffon took up the subject where Reaumur left it. Diderot, in the "Encyclopédie,"† in 1751, whilst acknowledging the superiority of English steel, ascribes it rather to the skill of the manufacturer than to its true cause, the superiority of Swedish iron.

Trial after trial was made year after year. Notwithstanding the favourable report of the Commission appointed by the First Consul in 1801, and of many other persons, as to the improvement that could be made in iron by the application of scientific treatment, it is now admitted by the latest French writers that the only cast steels, manufactured in France, which have successfully competed against the superior steels of England have been manufactured in the department of the Loire, *with Swedish iron.* In another work, M. Le Play, one of the most eminent chemists of Europe, expressly states that the only new principle introduced into practice in this century, in metallurgical workshops, was that of using the *hot-blast*, a plan adopted by manufacturers in

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is evidently considerable, owing to the *duty having been reduced January* 1855, from[a] 8*l.* 2*s.* 6*d.* on pig iron, and 8*l.* 7*s.* 4*d.* to 16*l.* 14*s.* 9*d.* on plates and bars, to the following:—

	£	s.	d.
Pig iron, per ton, entering France	1	15	4
Bars, according to dimensions — from	4	8	0
Bars, according to dimensions — to	6	3	4
Iron plates	8	16	0
Steel in bars, cast or wrought	13	4	0

Iron rails pay the same as bars; but iron plates for ship-building purposes are admitted free of duty, by a special exception.

* "Annales des Mines de France," 1846, page 25.

† Ibid, page 231.

[a] H. R. Lack, Statistical Journal, Dec. 1855.

opposition to the theoretical views then current.* Whilst no one looks forward with more hope than M. Le Play to the progress which *will be made* in metallurgy when the multitude of facts accumulated during the thousands of years in which the present processes of reducing ores have been employed (many of which processes, before his own investigations, had never been published beyond the workshops in which they were carried on) are accurately recorded, and have become a basis for true science to work upon, yet M. Le Play acknowledges how little aid pure science has been able to offer to the practice of metallurgy up to the present time (1848).

Unsuccessful as the long continued efforts of French manufacturers have been in bringing up their iron to the Swedish standard (the good properties of which depend upon the original quality of the ore), yet they have undoubtedly maintained the quality of their wrought iron, for ordinary purposes, to a point which is not exceeded by any other country, if we except that made into sheet iron in Russia.

From the small increase of 20 per cent. in the production of the sorts of iron smelted with charcoal in the last 26 years in France, whilst the cheaper coke iron has advanced in the same period 800 per cent., it is evident that the increased wants of the consumer have been almost entirely met by supplies of iron produced on what is called in France the *English* system of manufacture, namely, the introduction of high furnaces, with hot instead of cold blast, puddling furnaces fed with coal instead of lumping furnaces fed with charcoal, and rolling mills in the place of the hammers in use from time immemorial. That is to say, the demand on the part of the consumer has been in France, as with us, in a constantly increasing ratio in favour of the cheaper material.

With regard to the comparative quality of coke iron produced in the two countries, this is not only dependent upon the skill of the manufacturer, but upon the quality of the ores and coal employed.

Whilst there are some works well situated, like those of M. Dietrich of Niederbrohn, where no expense of manufacture is spared, and where choice ores are brought from a great distance, there are, of course, a much larger number where the aim is to produce a marketable article at the lowest possible cost. Still, in one of the late French expositions, the jury considered it the highest praise to pay to M. Dietrich, when they stated that his tires, &c., appeared to be in all

* "Annales des Mines," 1848, page 13. Pattinson's process of de-silvering lead should be also excepted.

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respects equal to those made at Lowmoor in Yorkshire.—French Jury Report, 1849, page 306.

As far as can be seen, in France as in England, it is the consumer who regulates the class of iron that is to be produced; as taste and demand change, so will the manufacturer follow; there is iron of all sorts and qualities in the French market, as in the English, and the relative proportion of best and common iron consumed in France probably varies from that existing in England, not because the French use more best, but because their common iron is so dear, that for many ordinary purposes they cannot afford to buy it at all.

The abundant and accessible supply of mineral fuel and iron ores in France has been already alluded to; and it is also in this very period that new lines of railways have been brought into operation, causing not only a great demand for mineral fuel for locomotive purposes, but also facilitating the progress of that great branch of industry which is now springing up in every country, namely, the carrying the metallic ores from distant localities to the mineral fuel with which they are to be smelted. Either the Revolution of 1848, long after its immediate influence had passed away, must have subdued the spirit of enterprise more than has been supposed; or, perhaps, the railways, laid out by Government with a view to cheap construction and to obtain routes diverging from Paris in all directions, have at present rather tended to the benefit of the public generally, considered as travellers, than assisted the special industry of iron, whose wants must be met by arrangements purely local. In England we are rather suffering from the opposite extreme, capital having been expended in undertakings got up for the benefit of local interests, and not altogether meeting the necessities of the general travelling public. Instead, therefore, of laying, as M. Chevalier—one of the most distinguished advocates of free trade—appears to do, the entire onus of the want of progress of the iron and coal trade in France, during a period in which Great Britain has made such an extraordinary advance, upon the protective duties levied on the importation of iron, I think it safer to mention a number of causes which have all tended in one direction during the last 10 years, many of which causes are accidental, and not likely to arise in the next decennial period. Such as,—

1st. The Revolution of 1848.

2nd. The want of railroad communication expressly organized to accommodate mining districts, and of proper rolling stock, stations, &c., for mineral traffic.

3rd. The apathy among manufacturers, caused by the system of protection, and the diversity of operations carried on by the same firm.

4th. The unfavourable sites formerly chosen for works, in regard to abundance of fuel and cheap carriage.

5th. The tenure of property, and the general system of carrying on works by paid managers and with the aid of capital raised by a number of shareholders engaged in other occupations; instead of as in England, where such business is generally conducted by persons who have risen from the ranks of the working population, and with capital made in the same trade. Their progress is much facilitated by the landlord being remunerated according to the minerals raised, and not by a fixed rent.

6th. The interference of Government with the affairs of the miner, and the deep-rooted superstition pervading the minds of shareholders and directors, that it requires a large amount of theoretical knowledge for the successful practice of the metallurgical arts, notwithstanding the evidence to the contrary collected by the President of the French School of Mines in his extensive travels.

7th. The ancient custom of using wood and charcoal, and the prejudice of smiths and founders against the use of iron manufactured with coke, through a want of acquaintance with the best modes of working it.

8th. The absence of banking accommodation.

TABLES indicating the depression in the French iron trade between the years 1847 and 1852, collected from Mr. Scrivener's paper in the "Journal of the Society of Arts," April 25, 1856; the figures are from the "Resumé des Travaux Statistiques des Administrations des Mines," 1847 to 1852.

FRANCE.

Year.	Iron Ore raised.		Charcoal Pig Iron.		Coke Pig Iron.		Total.
	Tons.	Per Ton.	Tons.	Per Ton.	Tons.	Per Ton.	Tons.
		s. d.		£ *s. d.*		£ *s. d.*	
1847	3,413,710	2 2	334.535	8 2 0	248,519	6 4 7	583,054
1849	1,740,913	2 9	247,703	5 19 0	160,516	5 0 6	408,219
1850	1,794,892	2 10	226,208	5 17 10	173,592	4 14 3	399,800
1851	1,748,771	2 11	243,543	6 3 2	195,833	4 13 9	439,376
1852	2,050,612	3 0	259,540	6 11 7	255,562	5 1 0	515,102

Mr. Lack gives the amount of pig iron manufactured in France in 1852, as 601,789 tons. The above, and in fact all such statistics, must therefore be considered as approxima-

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tions as to absolute quantity, but yet may give a true indication of the relative increase or decrease of trade in particular years.

France, Iron.

France.

(From Journal of the Society of Arts, April 25, 1856.)

Year.	Rails.				Iron Castings.			
	Tons.	Per Ton.			Tons.	Per Ton.		
		£	*s.*	*d.*		£	*s.*	*d.*
1847	87,466	13	11	2	108,066	15	15	7
1849	40,648	12	8	7	58,680	13	10	4
1850	22,754	12	5	2	70,267	12	17	6
1851	26,716	12	7	7	81,039	12	15	7
1852	59,590	10	17	7	88,800	12	18	2

The depression in the iron trade varied extremely in different departments. Since 1852 the destruction of the grapes by the *oidium* must have affected the resources of a considerable part of the population of France.

Mr. William Bird, who is largely connected with the home and foreign iron trade, and who took a very active part in the Exhibitions of 1851 and 1855, entirely agrees with the views of M. Chevalier. He considers the root of the evil to be the "leave-well-alone" system, which always follows a monopoly, and which was in full force before 1848. Mr. Bird remarks, that the canal system of France provided cheap and abundant transit for minerals, if the ironmasters had been disposed to avail themselves of it.

As an instance of the different views of the direction in which improvements are sought, and remedies applied for to Governments in different countries, I would remark, that whilst our ironmasters complain of the break of gauge, and of the want of railways to the docks on the Thames, as difficulties which they have to remove, the following translation of part of Michael Chevalier's Report upon the Industry of Iron to the jury of 1849, directs the attention of French ironmasters solely to the economical use of fuel, and not to the arrangement of ironworks so as to obtain the maximum division of labour, nor to the important point of endeavouring to obtain improved means of transport to bring ore from distant points to the coal, where, by working on a grand scale, iron can be produced in greatest quantity and cheapest rate; it is as follows:—

"The efforts of French proprietors of wrought ironworks are directed to the economy of fuel.

"Its dearness is the weak point of our metallurgical industry. We possess minerals in inexhaustible quality, dis-

tributed in a great number of places,—easy of extraction, rich, almost always of good, and in many cases of superior quality.

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"Some of our forges on the Haute-Marne and the Meuse only consume from 8*s.* to 12*s.* worth of mineral in producing a ton of cast iron; but in other cases, when wood is from 3*l.* to 5*l.* per ton, and coal from 24*s.* to 46*s.* per ton, the profit on the mineral is absorbed, except in case of very superior qualities of iron. Nothing is, therefore, more proper than that the attention of our employers of workmen should be directed to the economy of fuel. The means of obtaining this have been tried by more attentive superintendence and a thorough understanding of all the processes. By these means, evident improvement has been made; the conversion of wood into charcoal, and coal into coke, has been effected in a better manner.

"It was estimated, on the average, that in the whole of France, the coke made in ovens was only produced in the proportion of 450 from 1,000 of coal. At this time, 520 is produced from 1,000. There is also a slight gain on the coke roasted in hearths. The decrease in the consumption of coke in blast furnaces has also been marked in the last ten years, and in subsequent operations. Thus, on the average, from 1840 to 1847, the diminution of fuel expended has been,—

Consumption of coke, in the refineries has been reduced per ton of fine metal produced, in the proportion	of 1,000	to 818
Per ton of *massiaux*, in the puddling furnace	„ 1,000	„ 996
Per ton of hammered iron in the *Champenois* furnaces	„ 1,000	„ 985*
Per ton of hammered iron in the re-heating furnaces	„ 1,000	„ 893
Per ton of cast iron in the cupola	„ 1,000	„ 968
Per ton of drawn rod in the furnaces, for heating the rod	„ 1,000	„ 959
Per ton of plate iron in the furnaces, for heating the plates	„ 1,000	„ 793*

"This last reduction is the greatest; it shows that our iron plate works have made great progress. It is, indeed, one of the articles upon which the reduction of price has been the most marked.

"The idea of economising fuel has given rise to a great variety of experiments. There has not been bad success met with in employing coal instead of coke, and anthracite in blast furnaces; but what has been done in France is of small

* It is impossible to understand how statistics of any value can be obtained with such accuracy. By picking out very clever workmen, you may have iron puddled for an experiment with one third the fuel it is found best in practice to use, and the same difference will be found between the theoretical estimate and the fuel used in many other processes of metallurgy.

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account, for neither all coal nor all anthracite is suitable for this kind of innovation.

"The employment of anthracite has been recognized as very practicable in other countries, particularly in the United States and in Wales; there is, therefore, room for hope that some of the numerous deposits of this fuel that are concealed in France may be used for the industry of iron. We must not forget, however, the unfortunate ending of the experiment tried twenty years ago at Visille.

"Another kind of experiment for diminishing the cost of fuel, consists in using, in different manners, what is called lost heat; that is to say, gas which escapes in waste from the different furnaces. These trials have been of two sorts, viz., the application of gas directly to metallurgical operations, the refining of iron particularly; and secondly, the use of gas in heating steam boilers, or re-heating iron simply.

"The experiments of the first kind were very promising. Ingenious and learned men, the proprietors of ironworks, animated with most commendable zeal, have given up their time and their money; but after ten years of trials, and after an apparent momentary success, they have all abandoned the process.

"The success has, however, been complete of the application of gas to those processes of re-heating iron, and particularly to the generation of steam.

"This is a conquest now fallen to the share of the public, and used in a great number of factories."

The subject of consuming waste gases has been attentively considered both in England and America, and as it does not require expensive apparatus, and the system can be adapted to any blast furnace of ordinary construction, it has been extensively tried both in England, South Wales, and North America. The same result has been arrived at in all places, viz., that this gas can only be used for heating boilers, the hot blast, &c., and not for puddling, and as this process can be effected in South Wales at a cost of, perhaps, 1*s.* 6*d.* to 2*s.* 6*d.* for fuel per ton of pig iron produced, the maximum of the saving can be estimated. The minimum is more difficult, as in some cases it appears to diminish the quality of the iron to a small extent. The subject appears to have been well considered by most of our ironmasters, and it is certainly not from any unwillingness to entertain novelties that this system of economizing fuel has spread slowly in Great Britain, compared with the Continent and North America.

Whether the use of waste gases is advantageous or not, must depend upon a variety of circumstances; and, doubtless,

foreign and American manufacturers have exercised a wise discretion in adopting it; at the same time, it is possible that many manufacturers who have declined to adopt these plans, may have good reasons for their conduct.

France, Iron.

The course taken by French and English manufacturers differs widely, but that of each may be most applicable to the positions they are relatively placed in. It is only comparatively a few years since the duty of 6*l.* a ton was removed from foreign iron entering Great Britain, and since railways opened up the mineral wealth of the kingdom. Were the French ironmasters freed from all restrictions on their manufactories on the one hand, well supplied with convenient railways, and delivered from all protection on the other, we should doubtless see them availing themselves to the fullest extent of their mineral wealth, with marked benefit to their industrious and economical population, and to their national prosperity.

Prussia, Iron.

Prussia.—Prussia is another country in which the mines and ironworks, as well as the population engaged in them, have been taken under the protection of the Government Notwithstanding this care, and the great skill in metallurgy, for which the Germans have, from time immemorial, been famous, and notwithstanding the rich minerals and industrious population of Germany, it has only been since the introduction of the cheaper mode of manufacture, called the English system, that Prussia has taken its place as a large producer of iron. The extent of the production of iron in Prussia is supposed, by Mr. Blackwell, to be now at the annual rate of 300,000 tons,* which exhibits a great increase over the statistics collected by Mr. Banfield in 1846, published in his interesting account of the Industries of the Rhine. Mr. Banfield writes, page 116,—

"The following comparison shows the result of the German mode of mining and smelting, as contrasted with the system of association on a large scale, aided by improved machinery, practised in England.

"In Great Britain, where the annual production of iron was estimated at about 1,400,000 tons in 1841, the Census Commission found 10,949 miners, and 24,496 other persons engaged in the iron manufacture; this gave for one miner 140 tons, and for one workman 47 tons. In Prussia, 117,000

* Since this was written, the returns of iron ore raised in Prussia have been published, by which it appears that the production of iron in Prussia in 1855 exceeded 400,000 tons. The increase was, doubtless, occasioned by the Russian war.

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tons were produced in 1842 by 9,273 miners and 27,703 workmen, being 13 tons for each miner and 4 for each workman."

Thus, while the number of persons reported by the census to be employed in the same occupation in Great Britain and Prussia were nearly equal, the metal produced per man was ten times greater in one country than in the other.

Mr. Banfield enters at greater length into the causes of this remarkable difference than it would be possible to follow in this report. It will be, therefore, sufficient to observe, that after giving great credit to the members of the Governmental Mining Boards for their skill and intelligence, and after relating the high standard of education which is considered to be necessary for those engaged in mining operations, Mr. Banfield remarks, page 56,—"Yet the weak side of the Prussian system is forcibly illustrated in the mining department. All is there done under the control of the Government officials, who, however, acknowledge no responsibility. An *inexperienced youth* as 'Geschworner' or overseer, has the power of stopping all works if his suggestions are not carried out." Appeals from the overseer are attended with no expense, and are quickly despatched. But a more invidious interference arises out of the Government *tithe* (17 *per cent.*), exceeding the owner of the land's share by 100 per cent. of the gross produce of all minerals. The mode of securing this claim on the part of the Crown strikes at the root of all economy in mining. The *captain* (employed by adventurers), instead of being taken on *contract*, as in England, must be engaged *permanently*, and is sworn to the Crown as an official personage. He is thus independent of his employers, unless he commits any gross dereliction of duty, such as would incapacitate him from trust anywhere. The principle of competition, by which so much has been done in Cornwall, is by this regulation altogether rejected.

A *captain* in Germany is not a man to whom miners attach themselves through confidence; and he brings with him no *gang* for whom he is responsible. He is appointed as a foreman, and miners are engaged as they offer with the *sanction* of the Mining Board. Their *business* they generally understand; but the *discipline*, which is the element by which time is played off against money, and which allows high wages to co-exist with large profits, does not show itself. Without this element neither high wages nor large profits are practicable, as the history of Rhenish Prussia testifies. The condition of the labourer does not seem improved by his exclusive privileges; to prove which, Mr. Banfield remarks,—

"The miner, with bread and colonial wares dearer than in

England, besides the import duties on articles of clothing (which amount to an immense taxation of the country by raising the price of the domestic manufactures), is subject to a monopoly of salt, and the tax of personal service in the army, which rests upon all males between 18 and 45, and is enforced for some weeks annually. The truck system is also prevalent."

Neither (according the same author) was mining profitable to the adventurers any more than to the miners—the profits being absorbed in unnecessarily expensive works, to satisfy the regulations of the mining boards, instead of being invested in labour-saving machinery, which was generally absent, or else of quite insufficient character to meet the requirements of the present age.

Passing on to the manner in which the old furnaces of Rhenish Prussia (which in the Siegen district are all duly licensed) are managed, Mr. Banfield remarks, that they are not so numerous as in the middle ages, when great part of the world, including Great Britain, was dependent for steel to be wrought into arms upon their produce.

"The number of furnaces was reduced from 34 to 16." The next step taken was to limit the number of days which each of their furnaces was allowed to work.

Furnace at	Eiserfield	125 days.
„	Eisern	186 „
„	Huyn	91 „
„	Marienborn	128 „
„	Sieghütte	121 „
„	Haardt	62 „
„	Tiefenbach	62 „
„	Gosenbach	90 „
„	Birlenbach	92 „
		957 „

Thus nine furnaces were to perform the work of three that should be kept at constant work. The furnaces are all the property of numerous shareholders, whose portions are estimated in days. One man has, perhaps, twenty or more days, another five, another one, or even half a day. These days they can let to others, if they do not choose to use them.

In consequence of the regulations in this particular district, ore and charcoal have been exported beyond its limits. Then came the opening of the coal pits on the Ruhr, which cheapened fuel for the furnaces lying on the western boundary; and, lastly, the new roads carried off the pig steel to puddlers and hammer works in the coal districts.

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In attempting to lay down everything by rule, and to take care of the different interests of every class of the population, the ancient system of government has evidently succeeded in reducing, not only the actual produce, but the average wages of the population, below that of any other country in Europe. The new regulations, framed for the works on the English system, which have been started in the coal fields of Westphalia, Silesia, &c., have been much less rigorous; and it is satisfactory to see that in the district of Westphalia (where many works have been opened by private individuals), between 1853 and 1856 the iron ore obtained increased from 146,320 tons to 333,014 tons; whilst in Silesia, in the same period, where the trade is in the hands of noblemen and large public companies, the advance was only from 563,739 to 650,369 tons of ore. In the Rhine provinces, the advance was from 719,684 to 1,068,650 tons of ore, or about the average increase of the whole of Prussia. Whilst the total number of pits increased from 998 to 1,248, the Government only opened one additional pit, increasing from 29 in 1853 to 30 in 1855.

Then as regards the relations of the employers and the employed, Mr. Banfield observes,—

"In dealing with the workmen, the continental manufacturer occupies a different position from the English millowner. There is no floating mass of candidates for labour, who, if work is not to be had in one place, move off to a distant locality, and are never again heard of where they have been refused. The police and military arrangements prevent accumulations of strangers, unless there is some guarantee of their finding employment. The poverty that grows up with an increasing population, for which growing employment is not provided, is in Germany distributed amongst the peasants' homesteads, of course to the great relief of the parishes, but to the inconvenience of the manufacturer.

"It is from the peasants of the immediate neighbourhood that he must take his hands. On the one hand, he finds a responsible set of aids, but their number is limited; and if he wishes to enforce strict discipline, they are fully aware of the annoyance to which they can expose him. Large and successful undertakings often contrive to establish a population of strangers round their establishments, in the manner that we have seen at Oberhausen, Hammerstein, and Nisterdale; but it can only be done, at present, by forming a company which is willing to submit to the organization prescribed. Frequent allusion is made to the Belgian and English workmen, who have brought the modern system of iron making into Prussia. The new plan must have spread

rapidly, as the very favourable returns of the Prussian iron trade testify:—

	Iron produced.	No. of Miners.	No. of Workmen.
1842	117,000 tons	9,273	27,703
1849	286,981 „	8,987	25,657

"In 1849 the tons of ore raised were 1,513,570, and the value 801,122 thalers (120,168*l.*), or 19*d.* per ton.

"The ore raised by each miner was 168 tons, equal to 32 tons iron."

This only gives 13*l.* 15*s.* as the annual value of ore raised by each man. Of this sum, wages would, perhaps, form one half, the remainder being made up of mine expenses, interest of capital, Crown and landlord's dues and profits, &c., &c., leaving only 2*s.* 8*d.* per week for the average wages of miners. This amount, although far greater than what was earned in 1842, yet can still only suffice for the partial subsistence of the labourers employed, the remainder of their income being probably derived from the cultivation of the land, &c., &c.

The absence of good roads in the mountainous districts, where the mining is carried on, and the consequent enormous expense of cartage, even in fine weather, have been found by some of the English companies who have embarked capital in mines in Rhenish Prussia, a very great drawback upon profits, and is, of course, equally injurious to the interest of the workmen. Sometimes total stoppages of works occur in the winter through the wretched state of the modes of conveyance. In other parts, where water-carriage would be practicable, the Prussian Government have refused permission to have the shoals in the rivers removed by dredging, for fear of interfering with the occupations of that part of the population who have hitherto been supported by transporting minerals and iron along the public roads.

Notwithstanding this clinging to systems of political economy which have long been given up elsewhere, the search for fresh sources and kinds of minerals in Prussia has, however, not been neglected; and it is interesting to find, that not only has the Exhibition of 1851 been useful to the British nation in turning attention to mining localities within our own country (such as Northampton and Somersetshire, which have been neglected since the time of the Romans), but the visits of the foreign jurors to Scotland, in 1851, to observe the physical appearance of the black band ironstone, have led to the discovery of similar minerals in Westphalia. M. Karmarsh, of the Polytechnic School at Hanover, a member of both the juries of 1851 and 1855, informs me that—

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"The ironworks called *Hermann's Hutte*, at Hœrde, near Dortmund in Westphalia (distinguished by the gold medal at the Paris Exhibition), made coke iron from the black band iron ore found in the coal field in this district. There are now four high furnaces, each of them produce 12,000 lbs. of pig iron per day; 100 lb. of pig iron requires 150 lb. of coke; the quality of this iron is not superior."

The position Prussia has occupied in the political world in 1854 has apparently been favourable to the development of the industry of iron.

Besides the demand occasioned by her own preparations for war, and by those of Austria, her neutral attitude gave her an opportunity to supply any deficiency of iron that might be experienced in Russia, through the closing of the Baltic. The high prices of corn in 1854 must have prevented any great extension of ordinary commerce; and there does not seem any special development of railways in Prussia which could have, of itself, produced a sudden increase in the manufacture in iron; and therefore, apparently, nothing but the war demand can explain the results expressed by the following table—

	Tons of ore raised.	Value.	Miners.
1849	1,513,570	£120,168	8,987
1853	1,495,516	£134,772	10,035
1855	2,144,509	£212,054	12,581

(From previous returns it would appear that it requires five tons of ore to obtain one ton of iron.)

The increase of value per ton of ore has been ten per cent. between 1853 and 1855, besides an increase of ten per cent. between 1849 and 1853; the quantity raised per man is also much greater. From these causes, the value of the ore raised by each miner in one year appears to be 16*l.* 17*s.* 1*d.* in 1855. Upon the calculation that the wages amount to one-half the value of the ore raised, the average wages of a miner will be 3*s.* 6*d.* per week. From enquiries I made at Siegen, in September, 1856, the wages of a good minor are from 9*s.* to 12*s.* per week, having doubled since 1849; yet labour is scarce, on account of emigration.

From our census returns, we know that the emigration of Germans to Quebec, in 1854, was 11,034 persons; and in 1855 only 3,815 persons; and from the general decrease of emigrants to the United States and Australia, it is probable that the general emigration from Germany was diminished in a corresponding ratio.

It is interesting to find that the cessation of emigration is at least accompanied by a rise of wages in some branches,

giving a fair indication of the increased means of subsistence and increased comfort of the labouring population. Still there is much to be done in the way of a more liberal commercial policy, before masses of the industrious and intelligent population of Prussia regain the ground which they have lost during the unavoidable calamities of the early part of this century. Prussia, Iron.

The abundance in Germany, not only of minerals but of skilled labour for any work of metallurgy, has been well known since the Middle Ages; but still the actual increase of iron production, from 1830 to 1850, is only quoted at 60 per cent. in Mr. C. F. Wœrn's tables. No instance could be more appropriate to show what are the resources of Germany, when an extraordinary stimulus like that caused by the European war just terminated is applied, than the fact that the actual increase of iron production in 1854 and 1855 has equalled that between 1830 and 1853, and yet with scarcely any addition to the numbers of the mining population. The stimulus now withdrawn can be easily replaced by another, more constant in its character, and equally effective, viz., *free trade*, the good effect of which, in a country so well supplied with an educated and industrious population, and with such excellent mineral resources, can hardly be doubted.

That part of the Prussian collections at Paris which attracted the greatest attention, was not composed of specimens indicating the power and will of the Prussian manufacturers to compete with other nations for the supply of cheap iron, so directly essential for the material comfort of the population, and for the development of railways.

The great effort seemed to be made by the Prussian manufacturers to excel in the preparation of large masses of steel (one of the most difficult metals to manipulate), for the manufacture of which their country up to the beginning of the last century had stood pre-eminent. Specimens of cast-steel rollers, of cranks for locomotives, (valued at 3*s.** the lb.), of steel wheel-tires, and of an ingot of steel, of several tons weight,† were exhibited as the production of a single manufacturer (F. Krupp); a peal of cast-steel bells, the largest weighing $2\frac{1}{2}$ tons, was an entire novelty (from the Bochum works). These made a collection of objects in steel which, for size and apparent evenness of composition, have never been in any manner equalled in any other country. The cause of this pre-eminence is interesting to trace, since

* This was the price for one supplied to the Hayle Railway.

† In September, 1856, I saw at F. Krupp's factory, several steel shafts for French marine engines, 30 ft. long, and weighing, when finished, 11,000 lbs. each.

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it appears to have arisen as a consequence of the combination of improvements made in different countries; in the first place, the invention in Rhenish Prussia of making steel direct from the pig (by a puddling process); in the second place, of the introduction into Prussia of the Sheffield plan of melting instead of cementing the raw steel in order to adapt it for use; and, thirdly, in consequence of the enterprise of M. Krupp, and other manufacturers, in erecting extensive and powerful hammering and rolling machinery (such as had been brought to perfection in England for wrought iron manufacture) for working the cast steel into forms and for purposes which had never been contemplated by manufacturers in other countries, owing to the difficulties that had been met with; the nature of their previous materials rendering it nearly impossible to make a large and sound ingot of steel. For it appears that whilst the steel made in England from wrought iron to which carbon has been added in a converting furnace, is very liable to lose its proportion of carbon, with which it is only artificially combined; on the contrary, the Prussian puddled steel may be fused without any danger of losing its natural carbon, which appears to be intimately combined in its substance. The property of uniting in larger masses is also found to be much more powerful with puddled than with converted cast steel. Since the time that Reaumur, more than a century ago, drew attention to the possibility of obtaining steel, by a direct process of manufacture from pig iron, numerous trials have been made to accomplish this result, but unsuccessfully, until just prior to the Exhibition of 1851, when M. Krupp produced his first really successful pieces.

The material used by Krupp, viz., puddled steel, was one that could be procured in great abundance from the small manufacturers residing in a district where the ores were principally crystalline carbonate of iron (spathic ore) combined with a proportion of oxide of manganese, whose presence is now universally admitted to be most effective in the production of steel. The puddled steel also could be produced at a lower rate than even the natural steel used for cementation. The enterprise of M. Krupp owes its financial success, in some measure, to the abundant supply of his raw material, which enabled him to devote his attention to the melting and casting into ingots, and the subsequent rolling and hammering. The extent of plant required also had the effect of preventing competition; whilst there appears to have been so great a furor on the part of the directors of the Prussian Railway Companies, for introducing cast steel for all possible purposes, that M. Krupp was enabled to dispose of large

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quantities of work on the most favourable terms. Considerable interest was also excited in this country, and some sample cranks and tires were sent over; but the price has entirely prevented any extensive commerce in the articles. It was not possible to convince railway directors that it was good economy to purchase cranks, or tires, which must be as heavy as iron, and yet three times the first cost; and even now that a Sheffield manufacturer is offering these steel articles at only twenty-five per cent. above the cost of iron, the demand has been by no means extraordinary.

The great attention paid in Prussia to metallurgy perhaps explains the interest excited by a discovery which promises to introduce a new and most valuable material, by which it was hoped mechanical results might be obtained which were previously impossible.

Now that the Lowmoor Company are producing English puddled steel at very low prices, and that suitable plant is being erected at Sheffield, it is to be hoped that a full and impartial trial will be given to this new material by our railway companies, who are directly interested in the introduction of an article, which may not only wear longer, but be, perhaps, found so much stronger than iron, that the weights of machines in motion may be considerably reduced.

The remarks which have been made upon the iron miner and smelter in France becoming an agent for collecting from the public large sums of money, for the exclusive benefit of the landed interest, apply quite as strongly to Prussia, where the interest of the consumer, manufacturer, or labouring classes are not in any way allowed to interfere with those of the owner of the soil.

Many of the Silesian ironworks have been carried on by members of the nobility, who have established furnaces on their own estates, in order to derive the whole of their share of the indirect taxation levied on the public for the benefit of their own class; (viz., 1*l.* 1*s.* per ton on pig iron, and 4*l.* 8*s.* per ton on bar iron, the amount of the import duty.) They also, at the same time, retain control over the rate of wages paid to the labouring population residing on their estates, as they continue to be the sole employers of labour in their neighbourhood. And the wages earned by miners may be inferred, from the census returns already referred to, to be about 2*s.* 8*d.* per man per week in 1849, or about the sum paid in Sweden to a similar class of workmen ten years ago, previous to the abolition of the feudal rights and privileges of the nobility and of licensed ironmasters. If, however, the rate earned by the same class in Prussia, in 1849, were compared with that obtained in Sweden in 1855, it would be found that

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the wages per day paid in Prussia would only amount to one-fourth of that paid in Sweden, a country where the condition of the labouring class has improved more rapidly than in any other in Europe.

Besides the furnaces of the nobility, there are also numerous companies and a few private individuals engaged in the coal and iron trade in Prussia. There is, however, little or no competition, either for labour or for orders, for a close combination of the whole trade, both in Rhenish Prussia and in Silesia, has been established. So that when any large railway or other large contract for iron is advertised, only one tender is sent in, and the order is divided out in proportion, or by mutual arrangement among the associated ironmasters, so that there is no competition on the part of the sellers. The make of iron, until the Russian war, was also regulated so as not to disturb the low prices ruling in the labour market, the policy being always to keep the production below the demand.

During the last year, it is estimated that 80,000 tons of iron have entered the ports belonging to the Zollverein, the greater portion of which iron has been consumed in Prussia. The fact of a large quantity of iron from foreign countries having been purchased, notwithstanding the heavy duty, freight, and expenses, proves that a very high price has been maintained in Prussia, a country so situated, both in respect of abundance of minerals and cheapness of labour, that it could well compete in the open market of the world with any other country.

It would not be, therefore, too much to estimate the augmentation of price of all the iron consumed in Prussia at an amount equal to the duty and freight of foreign iron to Zollverein ports, which would be equivalent to a tax of nearly 1,000,000*l.*, levied on the consumer of iron for the benefit of a small privileged class of the Prussian community. Besides this, by the means, already described, of limiting the supply to a point below the demand, the ironmasters can secure a certain profit for the descriptions or sizes of iron they may like to make, whether or not they are the descriptions most in demand. When stoppages or delays occur, the consumer must wait till it is the pleasure of the ironmaster to proceed, as the bad states of internal communication often render the transport of heavy goods impossible. Complaints are useless, as the ironmaster has the resource of taking his share of contracts entered into by the representative of the united confederation, and he is, therefore, independent of any pressure that might be applied by the parties urgently requiring particular sizes of iron. Where the locality per-

mits, orders are frequently sent to England, from the difficulty of getting them executed in reasonable time in Prussia; and also because the Scotch iron suits better for the fine castings so esteemed in Prussia than the native harder descriptions of metal. Notwithstanding the privileges granted to the ironmaster in Prussia, which yield him an enormous profit, the regulations of the police and the policy of the landowners are such, that there is no floating mass of population eagerly seeking employment in whatever quarter it may be met with. The difficulties of internal communication, which it would be the first object of an English speculator to improve, are in Prussia under the care of the Government, whose duty it is to take care that no vested interest is interfered with. The refusal of the permission necessary to make the Oder navigable has been already referred to.* The mining board, police regulations, long credit system, and the general customs of trade, prevent much interference or competition with the regular mining interest either by means of natives or foreigners. The inevitable tendency of free-trade notions also prevents capitalists from embarking in an occupation where restrictions have to be submitted to, and where land has to be taken and taxes paid to Government, based on profits which would be preposterously high were the trade quite open. Since Mr. Banfield's work was published (1846) a great change has taken place in the transition from small to large factories, and the introduction of machinery instead of hand labour is rapidly taking place.

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I cannot, however, resist quoting his remarks upon the tendency of modern legislation in some countries to restriction on exertion :—

"Another motive for interference with private exertion is one that contrasts strongly with the care taken to promote popular education. It seems to be assumed that even an educated people will only use their power to their own destruction, unless they are guided, restrained, and directed from youth to age by the servants of the Crown."†

* "There was a large, an immense iron field in Silesia, but the means of bringing the production to market were uncertain. The Oder was not only full of shoals, but in the winter season was usually frozen for the space of two months, and the Prussian Government refused to have it dredged, because, they said, that by so doing they would destroy the traffic of carrying by carriages and waggons, and ruin thousands of persons employed in it."—Mr. Bird's Speech at the Society of Arts, Feb. 28, 1855.

† The estimates of the pig and wrought iron produced in Germany are so conflicting, that I have omitted them almost entirely, taking the statistics of iron ore in their place, which are probably well ascertained; the value of this is also given, and the number of persons employed in obtaining it, so that it appears a fair basis for reasoning upon.

In Scrivener's Iron Trade, the value of iron ore in Prussia was only estimated at 2*s.* per ton. This indicates extraordinary abundance.

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Sweden, Iron.

Sweden.—The history of metallurgy is associated with the writings of a distinguished Swede, Emanuel Swedenborg, the aim of whose writings was to elevate the common notions respecting the value of the science of metallurgy, by explaining the high philosophical interest that might be found in the investigation of the laws by which the metals were freed from the impurities with which they were naturally associated. The distinguished author of the great work just published by the French Government, "Les Ouvriers Européens," remarks, that the views which had influenced him to visit all the metallurgical workshops of Europe, were similar to those which had directed Swedenborg to the same task more than a century before. An extract from the writings of these two authors (so eminent, and yet so little known to the English public), who have at such different periods undertaken a similar work, will indicate the harmony of their views, and serve as an inducement to similar enterprises, which cannot but tend to draw closer the links between the science of the college and laboratory, and the practice of the workshop and refinery—objects aimed at by those who have promoted the great European gatherings of 1851 and 1855.

The method of smelting iron introduced by Louis de Geer in 1643 into Sweden, by means of workmen brought from the Walloon district, has retained its ground for the manufacture of the finest qualities of Swedish iron up to the present time. Every modern process has been attempted, but at present unsuccessfully, as far as imparting any superior quality to these ores, from which metal is produced which is said to differ in many respects from all the other irons known, as much as precious metals differ from ordinary ones.

Great attention to manufacture, combined with the introduction of the Lancashire forge and the aid of six families of English workmen settled in Sweden more than twenty years ago by an enterprising ironmaster, M. Wœrn, has produced an economy in the production, and an amelioration in the quality of the third or fourth classes of iron equal to ten per cent.

An official work is published from time to time, by the Swedish Government, containing the name of each forge and a drawing of its trade-mark.

TABLE of the principal FORGES of SWEDEN and NORWAY which produce the STEEL IRON destined for Exportation. Sweden, Iron.

Names of Forges.	Names of Provinces.	Number of Refining Fires.	Annual Produce of Forges.	Price at Sheffield per Ton. £ s. d.	Name of the Port of Embarkation.	Name of Mines which supply the Forges.
Lofsta	Upsala	6	630	35 0 0	Stockholm	Dannemora.
Carlholm	„	2	210	35 0 0	„	„
Gimo	„	2	210	32 0 0	„	„
Ramas	Stockholm	2	210	32 0 0	„	„
Österby	Upsala	4	362	30 0 0	„	„
Strombacka	Gefleborg	3	193	30 0 0	„	„
Strousberg	Upsala	2	230	29 0 0	„	„
Ullforss	„	2	200	29 0 0	„	„
Forssmark	Stockholm	4	399	29 0 0	„	„
Gysinge	Gefleborg	4	528	28 0 0	Gefle	„
Wattholma	Upsala	2	193	24 0 0	Stockholm	„
Harg	Stockholm		420	22 0 0	„	„
Skebo	„	3	115	21 0 0	„	„
Soderforss	Upsala	3	341	20 5 0	Gefle / Stockholm	„
Elfkarleo	„	4	256	20 5 0	Stockholm	„
Dadran	Kopparberg	4	305	18 12 0	„	Vindtjern et Skinnärang.
Svabenswerk	Gefleborg	5	315	17 5 0	Söderham / Stockholm	„ „
Avesta	Kopparberg	3	146	16 0 0	Götheborg	Vindtjern et Sjöqrufvan
Svartnäs	„	6	381	16 0 0	Gefle / Stockholm	„ „
Korssa	„	6	440	16 0 0	Gefle	„ „
Åmot	Gefleborg	1	291	16 0 0	Gefle / Stockholm	Vindtjern avec Sjöqrufvan et Sverdsjosocken.
Catherineberg	„	2	68	16 0 0	„	„ „ „
			6,446			
Bäckaforss	Elfsborg	6	492	18 10 0	Uddevalla / Gotheberg	Persberg.
Lesjoforss	Wermland	3	259	18 10 0	Götheberg	Persberg avec Langban.
Liljendal	„	6	452	17 15 0	„	Persberg avec Langban et Ramsberg.
Matforss	West Norrland.	6	420	17 15 0	Sundsvall / Stockholm	Persberg avec Langban et divers.
Lennartsforss	Wermland	3	279	17 5 0	Götheberg	Persberg and others.
Christinedal	Elfsborg	2	125	16 13 0	„	„
			2,027			
			6,446			
			8,473			

Sweden, Iron.

Names of Forges.	Names of Provinces.	Number of Refining Fires.	Annual Production of Forges.	Price at Sheffield per Ton.	Name of the Port of Embarkation.	Names of Mines which supply the Forges.
				£ s. d.		
Borjvik	Wermland	4	310	16 13 0	"	Persberg, Langban, et Ramsberg.
Storforss	"	8	545	16 5 0	"	" " "
Bjurback	"	3	236	16 5 0	"	" " "
Oxnäs	Elfsborg	4	278	15 15 0	"	" " "
Næs and Westre Röe.		4	698	18 10 0	OsterRüsoa	Mine de Sélberg et autres (Groupe D'Arendal).
Laurwig		3	420	18 10 0	Laururg	Different mines of Groupe D'Arendal.
			2,487			
Uddeholm	Wermland	10	832	17 15 0	Götheberg	Langban avec Taberg et Nordmark.
Stjernforss						
Gustafsforss						
Loviseberg						
Föskeforss						
Munkforss						
Uprana		10	832	16 15 0		
Halga						
Wära						
Likana						
Femta						
Snöa	Kopparberg	2	127	16 0 0	—	—
Andersforss	"	4	272	16 0 0	—	—
Ericsforss	"	3	210	16 0 0	—	—
Tollforss	Gefleborg	4	336	15 10 0	Gefle	Bisberg.
Meldersstein	Norrbotten	4	111	16 0 0	Lulea / Stockholm	Gellivara.
Toreaforss	"	2	125	16 0 0	"	"
Mackmyra	Gefleborg	2	166	15 5 0	Gefle	Bisberg.
Thurbo	Kopparberg	2	137	15 15 0	Stockholm	"
Wikmanshyttan	"	2	68		"	"
Nornsberg	"	3	210		"	"
Hammarberg	Gefleborg	4	340		Gefle / Stockholm	Risberg et divers.
Risshyttan	Kopparberg	2	144		"	" "
			3,910			
			2,487			
			6,397			
Hoforss	Gefleborg	2	168	15 5 0	Gefle / Stockholm	Bisberg.
Robertsholm	"	2	169	15 5 0	"	"
Stjernsund	Kopparberg	3	250	15 5 0	"	"
Rorshyttan	"	2	126	15 5 0	Stockholm	"
Garpenberg	"	7	440	15 5 0	"	Bisberg and others.
Horndal	"	4	252	15 0 0	Gefle / Stockholm	Bisberg and Norberg.
Elfsbacka, 1st mark	Wermland	5	302	15 10 0	Götheberg	Nordmark with Engrufvan and others.

Sweden. Iron.

Names of Forges.	Names of Provinces.	Number of Refining Fires.	Annual Production of Forges.	Price at Sheffield per Ton.	Name of the Port of Embarkation.	Name of Mines which supply the Forges.
				£ s. d.		
Anneforss,	„	1	36	15 10 0	„	„
Lofstaholm,	„	4	117	15 10 0	„	„
Lenungshamar	„	2	135	15 8 0	„	Nordmark and others.
Brunnsberg	„	4	299	15 5 0	„	„
Ransäter-nedre	„	2	138	15 0 0	„	„
Elfsbacka Anneforss 2d mark	„	–	228	14 15 0	„	Nordmark with Engqrufvan and others.
Lofstaholm 2d mark	„	Sup			„	„
Norum,	„	1	88	14 10 0	„	Nordmark with others.
Upperud,	„	5	390	14 10 0	„	„
Godgard	Oster Göthland.	4	190	15 0 0	Norrköping Stockholm	Uto and others.
Strombacka, mark inferior.	Gefleborg	3	258	14 10 0	Stockholm	„
Hedvigsforss	„	3	223	14 10 0	„	„
Fagersta	Wermland	4	275	14 10 0	„	Norberg.
Gasjö	„	2	166	14 10 0	„	„
Westanforss	„	2	183	14 10 0	„	„
Engelsberg	„	4	323	14 10 0	„	„
			4,747			
			8,473			
			6,397			
			19,617			

Besides the foregoing amount of products which are made for exportation, there is another item of about 9,300 tons (valued at 14*l.* per ton), which are made use of for home consumption, and also in the fabrication of steel destined for exportation, making a total, when added to the former amount, of 28,917 tons for the year 1845.

The names of the Swedish and Norwegian forges which produce the steel-iron suitable for exportation have been published by M. Le Play in the "Annales des Mines de France," pages 135 to 139, 4th series, vol. 9, 1846. The prices are tolerably correct at the present time, and represent the comparative value of the superior and inferior qualities at the present time in the Sheffield market. These Sheffield prices are, of course, much higher than those in Sweden; for the merchant has to add his profit, export duty, freight, and carriage to Sheffield, and a sum for the risk of the nine months' credit at which iron is sold. M. Le Play remarks, that the first are now double the cost of the third and fourth classes, whilst in 1766 they only sold for fifteen per cent. more. The Swedish Government has always taken a great interest in the development of the iron industry; and instead of (as in other countries) making the ironmaster dependent

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on the landowner for his supplies of charcoal, each forge had certain rights of obtaining wood at very low prices; and only a limited number of forges were licensed. Notwithstanding these arrangements, and that an excellent trade was carried on for exportation, the earnings of the population were anything but satisfactory; indeed, a large number of labourers, anxious for work, could be obtained at the low rate of 5*d.* per day; and whilst agriculture was at a low ebb, and labour superabundant, foreign grain was annually imported. In order to ameliorate the condition of the people, the Swedish Government, lately abolished the feudal rights and privileges of the nobility, who had enjoyed previously certain preferences as ironmasters; and the iron trade was left to be supplied with its fuel in the open market. Although the exportation of iron has not materially increased, the main object—the welfare of the labouring population—has been promoted. The price of charcoal rose to three times its former value, wages have risen from 5*d.* to 2*s.* per day, and workmen are difficult to obtain. The first parcel of guano was imported into Sweden in 1850, by Mr. Wœrn; its consumption has steadily increased year by year; already, in 1856, nearly 1,000 tons of this invaluable manure have entered Swedish ports; whilst during last year, instead of importing, Sweden was able to export an enormous quantity of grain. Until very lately, the exportation of pig iron was prohibited, in order to encourage the manufacture of bar iron in Sweden; this law is now repealed, and pig iron can be either exported or imported by payment of a duty of 12*s.* 6*d.* per ton. It is hoped that the prohibition upon the export of iron ore will soon be repealed, as this would open out a new field of industry both for Sweden and Great Britain.

The mountainous character of the country and the badness of the roads when the snow melts in Sweden render transport expensive; and at the present time ore, which is very abundant in particular districts, is carried to distant forests to be smelted. Here, therefore, we see the parallel of what is taking place in our own country—the carrying ore to the fuel it is to be smelted with; the reverse operation seems more rarely met with. The following table is extracted from Scrivener's valuable work, the "History of Iron:"—

Production of Iron in Sweden.

Years.	Average Produce. Unwrought Iron. Tons.	Bar Iron. Tons.		Average Exports. Bar Iron. Tons.
1833 to 1839	89,610	73,592	all countries	58,766
1840 to 1844	105,485	84,041	„	66,046
1845 to 1849	106,630	90,466	„	74,069
1850 to 1852	124,169	99,889	„	75,940
1854 From Board of Trade Returns to Great Britain only				40,891

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The countries to which exported is not published, but the report of the British consul at Gottenburg gives the following table of the exportation from that port, which may probably indicate the general distribution of the iron:—

Shipments of Iron.	1854. Tons.	1853. Tons.
To Great Britain	18,550	20,400
To America	7,700	4,800
To other Countries	4,450	4,900
	30,700	30,100

The exportation of Swedish steel-iron into France has increased since the year 1838, when it seriously commenced, perhaps in a greater ratio than to any other country, particularly during the last few years; whilst the exportation of English steel to France, which began to decrease in 1840, has diminished from 1,500 tons in 1840 to 413 tons in 1854. On the other hand, the exportation of Swedish iron to the United States has increased immensely, on account of the great demand in the States for first-rate qualities of iron, to be used for general forge purposes; and the demand in America for steel has been so enormous, that the exportation of steel from Great Britain to North America has actually trebled since 1850.

The reduction in the price of many descriptions of steel in great demand (on account of their being now made of English iron) ought to have increased the general consumption of steel in France, had the manufactories of that country been in the active state that the splendid exhibition of their products at Paris in 1855 would have led us to believe. It will be interesting to observe if this has really been the case. The following table presents the subject in its true aspect:*—

	Swedish Iron, consumption in 1845.	Swedish Iron, consumption in 1854.
Great Britain	16,200	24,436
France	1,300	2,000
United States	1,300	10,000

The development of the trade in steel-iron between Sweden and France was one of the great objects of M. Le

* Austria, which in 1842 produced 12,800 tons of steel, probably consumed no Swedish iron. Mr. Sanderson estimates the production in Austria at 13,037 tons.

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Sweden, Iron.

Play, the director of the French School of Mines, and even with the present high tariff on foreign iron, his labours have been crowned with partial success, and there is no doubt that if the reduction in the duties on foreign iron, which he has so long advocated, were to take place, that France would assume a position in the steel trade (as far as regards consumption) equal to that of any other nation with the same resources. Many manufacturing trades in France have languished through the employment of French steel, although really inferior to foreign; and also from the difficulty experienced by the consumer in obtaining particular marks and qualities of foreign steel, when required for special purposes, owing to a general system in France of counterfeiting the marks of the best foreign makers. Every precaution was taken in Sweden to prevent any such occurrence, and an official book was published with the particulars of the distinctive marks or brands belonging to each forge. Besides this, the "Jern-Vagen," was an institution to secure by inspection that only good iron was branded; at the present time, inferior *rolled* Swedish iron is branded.

The following letter from Mr. D. Forbes, a well-known metallurgical chemist, will be found to afford some interesting particulars relative to the iron manufacture of Sweden:—

"I have resided many years in Norway, and have made frequent visits to Sweden on metallurgical expeditions; in Norway, in particular, I have had every opportunity of acquiring a knowledge of the metallurgy of iron; and having had several blast furnaces at my disposal for experiments, have tried many such on the large scale.

"I had thought that the only experiments made on this subject (addition of iron pyrites) were those made by myself. I did not, however, find the results very satisfactory, and in trial bars found the strength diminished. I found, however, that *malleable* iron, with about three per cent. of sulphur, sometimes showed a very great increase of strength.

"The size of the blast furnaces, both in Sweden and Norway, is generally about 30, to, highest, 36 feet high; and the lower part (say 10 feet), composed either of sandstone or firebrick; above this, generally, the furnace (from 8 feet above tuyeres) is built of *slag* from the blast furnace, cast into bricks about 12 × 8 × 8 inches, which stand admirably, never melt, but undergo a change in molecular constitution somewhat similar to Roman porcelain from cementing glass. One to three, but generally only two, tuyeres are used, and generally not above $2\frac{1}{4}$ inches diameter.

Sweden, Iron.

The blowing machines, with the exception of the newer ones, are generally very bad (wooden cylinders and bellows), but as power is generally no object, they work very well. Great attention is paid to the roasting of the ores, which is done by the refuse small charcoal, or by wood in peculiar furnaces; but of late years a number of roasting furnaces of the waste gases are employed. Particular attention is also paid to the size of the ore charged into furnace, and it is broken up by hand or water-hammer (lately by rollers), to about the size of walnuts, or even less, generally, if not always, after having been previously roasted. The charges of ore and charcoal are very small at a time, but nearly incessant, so as to cause a more regular smelting.

"The mixture of ores is more important in Sweden with reference to the smelting capabilities than to the quality of the iron employed, as many of the ores would not in themselves smelt so as to produce a sufficient amount of slag. Very little, and generally no lime is employed, and poorer ores,—in which the gangue are silicates of lime, magnesia, alumina, &c.,—are added to those of a less content of gangue. In the south of Norway, they mine large veins of a mixture of garnet, epidote, coccolite, colophonite, and various other silicates, to use as a flux in the furnaces; they work admirably.

"In speaking of the qualities of iron—as grey and white iron—it must be remembered that in charcoal furnaces working nearly pure oxides of iron, the relation of these two sorts is widely different from that they bear to each other here in England; and as the great object in Sweden and Norway is to produce bar iron (not castings) where the ores used are good, then the smelter prefers making white iron entirely. If the ores are of a less good quality, it is frequent to take the metal (grey) direct from the blast furnace into a small refinery, and oxydise it slightly, so as to make white iron for the further subsequent conversion into bar iron.

"Puddling was introduced into Sweden from England, in 1819, but has never gained ground until, I believe, lately, in some districts which I have not visited; and this chiefly owing to the nature of the fuel, and necessity of using dry wood. Since, however, the gas generators (with charcoal) have of late years been employed, I believe it is much more used in certain districts. In Norway, I do not know of its being at all used, except in trial workings: the greater part of iron is made now in the Lancashire hearths. I am not aware of magnetic oxide of iron being added in puddling in

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Sweden, Iron.

Sweden, but think not. In America I believe it has been generally used for a long time; and about six years ago I introduced it into Poland,—where I am in connexion with some ironworks, driven by charcoal,—and used an addition of roasted sphærosiderite* in the Lancashire hearths with apparent advantage, so it is now come into general use; the advantage is, I think, only in causing more slag, and a better separation of the slag from the bloom.

"With regard to cannon iron the Government are very particular; and those private works intending to tender for cannon are bound to keep the blast furnace expressly for this use, using only ores from stated mines, which are most carefully analysed, and the freedom from both *sulphur* and *phosphorus* attested; also only cold blast used; testing bars are constantly tried, and some Government officers are regularly on the spot, as long as the contract goes on. Even if only for shot or shell, the greatest care is employed in examination, and the result is the production of articles much superior to the English. *The greater part of the cannons, employed by the Russian Government are made in Sweden.*

"I send you, per post, a small specimen of one of the ores expressly used by the Norwegian Government for cannon; in attempting to break it off a larger piece, it has gone all to pieces, but you can imagine a loose aggregate of such particles, forming a very fine ore.

"I find amongst my old note-books a number of memoranda about Swedish iron for cannon; and amongst others, the analysis by Holmgreen of cannons cast from some furnace where most of the Government cannons were cast in Sweden,—the one of first-rate quality, the other very bad (*i. e.* for Swedish cannons):—

	Good ore.	Bad ore.
Silicon	1·300	1·730
Carbon	2·900	4·300
Sulphur	1·810	1·198
Calcium	0·375	0·450
Magnesia	0·126	0·115
Alumina	0·030	0·005
Manganese	1·625	2·650
	+ Remainder, iron.	

"The good was grey, fine texture all through, although rather more compact at sides; the bad, white round circumference, particularly at the corners of casting, and grey in

* Clay ironstone.

centre; some graphite foliæ observable. The slag from the good iron contained of Holmgreen's analysis,— Mr. Tylor on Metal Work.

Sweden, Iron.

Silicon	61·97
Alumina	3·96
Lime	20·37
Magnesia	2·78
Protoxide of Manganese	7·25
Protoxide of Iron	4·07
Sulphur	1·73
	102·13

"The per-centage of iron in the ores of Norway and Sweden averages from 35 to 45."

Russia.—The latest information respecting the production of pig iron in Russia is contained in the statistical table for 1855, published by the British Government, and is as follows:—

Pig Iron manufactured.	
1838	171,028 tons.
1850	187,672 tons.

Russia, Iron.

This very small increase, in a period when the consumption of iron in the world has doubled, quite agrees with the observations of Le Play, published in 1846, and after his visit to Russia. This visit happened at a time when the manufacture of iron rails for the railway from St. Petersburg to Moscow was attempted. It appears that although at the instigation of the Government, a central factory was actually established for rail making by the associated ironmasters, and in 1844 some specimens were finished, and which already offered most of the characteristics of a good manufacture, yet it was found on trial that the quantity of fuel required for this new branch of commerce demonstrated that the forest resources of Russia would not suffice both for the consumption of the new and the old customers. Notwithstanding, therefore, that the contractors of the railway were bound to use this Russian iron, and to pay for it 66 per cent. more than the price of English iron, and although the national feeling was greatly excited on the subject, yet no native ironworks could undertake the contract, and it was accordingly entirely executed abroad.

Since that period Russia has been a regular importer of iron from this country, although at the same time exporting a considerable quantity of sheet iron to America, and continuing the supply of iron for steel purposes, which has been for many years a regular article of export to Great Britain.

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Russia, Iron.

The facts respecting this railway contract demonstrate that the ordinary consumption of iron in the Russian empire is nearly *in equilibrio* with its present means of production under the feudal system sanctioned by the Government, which prevents the wood being used to the best advantage, and also retards even such improvements as the introduction of wheeled carriages.

The progressive consumption of iron is an index of general prosperity; and, in the case of Russia, appears extremely small considering the size of the country, viz., about one-fourth of that of France, one-sixth of that of the United States, and one-tenth of that of Great Britain. If the consumption of iron per head of the population is compared with that in the above-named countries, it will be found still more unfavourable to Russia. The absence of any greater production of iron in Russia than in Sweden, a country comparatively so much smaller, may, to a great extent, depend upon the want of roads to bring the ore to the fuel, to the bad management of the forests, and to that want of inducement to make any change or improvement which is consequent on the preservation of their feudal privileges by the landowners. These not only keep a large part of the population in serfage, but retard that spirit of progress in the peasantry which is nurtured in countries where the home of the cottager and his possessions are as much protected by law as the castle of the nobleman.

Whatever may be the causes of the absence of increase in the production of iron in Russia, they must accord with the explanation already given, that the great increase in the production of iron in Prussia during the years 1854 and 1855, after a stationary term of four years, is mainly caused by the Russian demand during a period when a larger quantity than usual was required, and the ordinary sources for its supply were closed up.

The great development of the gold washing in Russia has been the most remarkable feature in its mining annals. Indirectly this source of wealth, amounting to 4,000,000*l.* per annum, has caused a sudden demand for a great number of tools and objects in iron. The machinery employed in Russia for this branch of industry alone must be very considerable, for the proportion of the gold in the alluvium, although sufficient to pay for working, is often only one part in 2,000,000; and there are cases where the refuse of former washings, containing only one part in 4,000,000, is re-worked. It is also said that 50,000,000 of tons of material are manipulated

in one manner or other in the search for gold, which is more than is accomplished in the united coal and iron mines of Great Britain.*

Russia, Iron.

In Russia it is the manufacture of sheet iron that has progressed the most. This is used for the manufacture of a great number of domestic utensils, for the art of *fumisterie*, (stove and stove-pipe work), for covering houses, and it is also in the form of sheet iron that the exportations to North America principally are made. The reason of this extension of the Russian iron trade in one particular direction is that the ores of Vouissokogorsk show such marked qualifications for this branch of manufacture that the manufacturers, by converting their iron into sheets, get 50 per cent. more than they would obtain if the same ores were made into bar iron. This iron is worked up in the United States into implements of husbandry, spades, horsenails, &c., and is also most useful for the manufacture of harpoons. These instruments are required in great numbers and of the best quality by the Americans engaged in the northern whale fishery, a branch of commerce which, without any special advantages of position or markets, has been conducted in the United States in so able a manner as to have almost entirely withdrawn it from the hands of British competitors.

The best qualities of Russian iron derived from two districts are used for the manufacture of steel of middling qualities; and Le Play remarks that "the most considerable source is a large mass of oxide of iron at Vouissokogorsk, situated on the eastern or Siberian side of the Uralian mountains, a little to the north of Ekaterinoborg. The second is more to the south-west of the same city. The same kind of iron is worked up into steel and into the sheets already mentioned. Its superior quality is owing to the natural steely propensity of the iron, to the care with which it is worked, and to the quantity of charcoal fuel used during the operation."

In 1844 it was thought that 2,500 tons of steel were produced from the iron obtained from the above-named sources. During the same year an equal quantity of the raw iron found its way to Sheffield, notwithstanding the extraordinary difficulties of the transit by which the manufacturer was prevented from realising the value of his productions in less than two years and nine months. The remainder of the iron worked into steel in Russia and derived from other sources was estimated at about 900 tons. Mr. Unwin of Sheffield thinks that at the present time 4,000 tons of Russian iron are con-

* These are the statements of M. Le Play.

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verted into steel in that town; principally of two marks, the CCND. and KB. The best carding wire drawn in England is made from Russian and Swedish blooms. This explains the superiority of the English carding wire sent to the Paris Exhibition.

The truth of the remarks of Mr. Bird that the free introduction of foreign iron in the shape of rails does not interfere unfavourably with the trade of the ironmasters in the country in which the railway is made, could be as well illustrated in Russia as in any other country. The facility of transporting not only minerals from the mine to the seat of manufacture near the fuel, but the finished product to the local markets, gives an immediate impetus and means of progress to the local iron trade which it could not otherwise gain. This has been felt by the enlightened Government of Sweden, a country similarly situated to Russia, and where foreign iron can now be introduced. Not only has the wealth of the landed interest been increased by the rise in the value of charcoal of 300 per cent., but by the immense stimulus given to agriculture arising from the increased means of purchase possessed by the labouring classes whose wages have risen 400 per cent. The financial resources of the whole country have been thus augmented in Sweden by removing restrictions on individual enterprise, and this without any complaint of injury by those for whom special privileges (so-called) had been provided by legislative enactments. It is now admitted that these enactments never produced any benefit to the parties they were intended to serve, but, on the contrary, introduced an element which retarded the progress of the whole population.

In any country where trade is not allowed to find its own level, but where particular manufactures are sought to be promoted by special privileges granted to individuals or companies, the profits of trade do not depend upon supply and demand, but upon Government. There is no inducement to manufacture cheaply or well, or to seek for better investments. Only the hope of enormous profits will tempt foreigners to engage in any speculation in a distant country where a monopoly or privileges may on any day be granted to some more favoured individual, or entirely withdrawn. Were the import and export of the staple articles of manufacture, and of the machinery to work them with, left perfectly free in Russia, and were foreigners allowed to follow their own judgments in choosing the mode and locality for carrying on their trading operations, those branches of commerce and manufacture would soon be created for which the productions of the soil and the character of the Russian population are most suited

Russia, Iron.

The history of progress during the last ten years, in many countries where restrictions have been withdrawn, clearly shows that the public revenue has not suffered, and that the profits of the proprietor of the soil, of the capitalist, and of the labouring classes have all advanced. Such a fact proves that the days of legislation for special classes are numbered. In all countries, competing against each other in their own or in foreign markets, processes of manufacture are assimilating; and wages everywhere are disposed to rise to the highest standard, and not to fall to the lowest.

We know but little of the condition of the workmen employed in metallurgy in Russia; but the story of the first Demidoff, an intelligent working miner, having been presented by the Czar with an immense mineral tract, rivals the stories told of the munificence of Eastern monarchs, and indicates the estimation in which skilled labour has been held by the Government. This particular gift was a homage paid by the Emperor to the principle of labour; but it was, also, an enunciation of another principle, namely, that the Emperor was the fountain from which the rewards of industrious and intelligent workmen must flow. The success of Demidoff depended principally upon his having received the approbation of his Imperial master, and would not have as encouraging an effect on the class to which he belonged, as the knowledge that equal wealth and honours could be attained by a workman who had simply exercised his own talents without asking or receiving a favour.

While, in St. Petersburg, lucrative Government appointments have been given to scientific foreigners, and foreign merchants and manufacturers, having been invited to settle, have languished under the shade of the Imperial wing and of protective duties, the real progress of Russian manufacture must be looked for in the remote districts of Siberia, and that of commerce in the grain-growing districts of the south. The industries of gold and copper mining carried on in the neighbourhood of the Ural mountains, and that of grain-growing in the south of Russia, are branches of trade and commerce in which the Russians have made rapid strides, and in which they compete successfully with the whole world. It is important to remark, that these industrial occupations have progressed without any special legislation, and without protective duties. The able manner in which the gold, distributed in minute quantities through the soil, is rendered of commercial value by the skill of the Siberian workmen, and the extent to which they have applied machinery, have been already alluded to. Their practice affords

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a lesson which might be applied with benefit to those engaged in similar occupations in California and Australia.

Russia, Iron.

The power of originating modifications in metallurgical processes, so as best to suit the various ores of the copper that have to be smelted, has been successfully exercised in South Wales by the Welsh workmen. Le Play has particularly alluded to their skill and intelligence, after examining minutely the result of their practice by the test of chemical analysis. The same author describes the result of his experience among the metallurgists of Siberia, as furnishing him with illustrations of a similar kind. After quoting a remark made by a Siberian, which proved that this workman, in so remote a district, had observed and understood minute differences between the copper slags produced at different stages of the smelting process, and which the French chemist had discovered by his own scientific investigations, Le Play says, "the remarkable comprehension of very delicate phenomena by a Siberian founder appears to me worthy of attracting the attention of persons who think that the physical and chemical reactions of metallurgy are abandoned to an ignorant routine. On a hundred other occasions I have profited by the conversation of workmen; and if, at the end of so many travels, I have anything to regret, it is that I have sometimes neglected the remarks made by workmen (*practiciens*), and which appeared to me, perhaps, useless or inexact, because I was not prepared to comprehend them. Finally, those who think that the science of metallurgy is not thoroughly possessed by those who practise it, and who suppose they may represent it as a simple corollary of principles laid down *to-day* by the physical sciences, can submit their opinions to the test of experience. They ought to attempt to execute themselves, according to the indications of their theory, the operations abandoned until this day *to routine*. I affirm that in this manner they will not be long in discovering their error; and that they will soon see, in a clear light, the *true* foundations of metallurgy, and its means of progress." ("Annales des Mines," 1848, vol. 13, p. 214.)

In another part (page 16) of the same work, Le Play remarks:—"For instance, I have found that many educated people believe that the extraordinary progress which has taken place in the Siberian mines is the result of the violence which detains in that locality an oppressed population. These persons find it difficult to believe that the metallurgical processes of Siberia have, in some respects, attained a degree of perfection which is not rivalled in any other part of the globe; and that these plans have been invented by workmen

(*practiciens*) devoted to their occupation, and attached to their native country" (Siberia).

Russia, Iron.

The extraordinary production of grain, for exportation to Great Britain, which took place in the south of Russia immediately after the abolition of the English corn laws is an evidence that the agricultural population were prompt in entering into a trade which promised to be profitable. If the class legislation of Russia and its protective duties were removed, we cannot doubt that fresh branches of commerce would grow up without any artificial assistance, just as it has been in Sweden, and rapidly augment the means of the labouring population, the first stage in the production of national wealth. The immense resources of Russia would then be developed by its own hardy and, we may now (after the remarks of Le Play) add, its intelligent population, if the system of legislation allowed them fair play at home, and gave them the stimulus of foreign competition.

The discovery of mineral-fuel, the want of which is so great a bar to manufacturing industry, may be made in some other and more accessible parts of Russia, and be found in greater abundance than in those districts in which it has been already worked. The recent discovery of coal measures, made by boring near Valenciennes, in a locality which was not thought by geologists a favourable one,* prove that too hasty conclusions as to the non-existence of coal in particular areas should be guarded against. However this may turn out, there seems to be no possible reason why the production of iron in Russia should not amount to a total more in proportion to that of Sweden when the respective areas of the two countries are compared, particularly as Sweden possesses no coal and is not more favourably situated as to climate. It is, however, better situated as to internal communication, Sweden being so intersected by rivers and deep bays that open transits by water from all parts, while the difficulty of transporting bulky articles is so great in Russia that, until railroads are introduced, the conditions which would enable new ironworks to prosper could not be established.

M. Tegoborski, in his Commentaries on the Productive Forces of Russia, (Longmans, 1856,) enters very fully into the subject of the deficiency of iron in Russia, and the injurious effect produced upon every branch of industry by this cause. He states (page 137, vol. 2) that the Uralian iron works alone employ 150,000 workmen; and that those in Poland and Finland make up the total number to 225,000. From page 128, it appears that the wages paid are about 6*d.* a day

* A map of the district and letter by MM. Degoussée and Laurent of Paris are omitted for want of space, and are published in the Geological Society's Journal for 1856, page 252.

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to each workmen. But, in comparing the work done, it does not appear that iron is made cheaply in Russia because the wages of labour are low and charcoal fuel is to be obtained at a nominal rate; ten times as many people appear to be employed as would be necessary in this country. The mode of iron making is so wasteful, that actually as much money is paid for the work done as in other countries, where the labourer earns 12*s.* or 15*s.* per week.

The effect of the Russian system is, that the workmen can spare nothing with which to purchase either foreign produce or home manufactures. This appears to have been the case until lately, both in Sweden and Prussia. In these countries, however, the recent liberation of an amount of labour for profitable occupation, which was formerly employed on unnecessary work, has produced an extraordinary effect on the productive powers of the whole industrial population of Sweden and Prussia.

There is nowhere so much room for this desirable change as in Russia.* Throughout a great part of the empire, farm-horses are without shoes, and farm carts without tires to the wheels; axles are of wood; spades of wood covered with a thin coating of iron; and in many districts, the ploughshare itself is of wood with an iron point. While labour can be had to any amount for 6*d.* per day, and the iron master has a right to cut his wood without paying for it, in the forests granted for his use by Peter the Great, and while there is no foreign competition, it appears probable that the production of iron in Russia will remain stationary, and the progress of the whole population be retarded. No iron could be imported by sea, and the duty by land on pig iron was 600 per cent.† This country ought, therefore, to have been the Elysium for protectionists, and yet Tegoborski shows in the following table, that it is Russia itself which really suffers by the high tariff.

	Production of Pig Iron.	Production per Inhabitant.	Consumption per Inhabitant.
	poods.	*lbs. Russ.*	
England, 2,500,000 tons	152,812,000	231	138·4
France, 5,379,796 metr.-quintals	32,859,000	37·5	43·8
Russia, including Finland, and the kingdom of Poland.	15,000,000	—	—
„ exclusive of Finland and Poland	13,105,000	8·7	9·7
Austria, 3,594,789 centners	12,303,000	13·5	12·3
Prussia, 2,480,686 centners	7,584,700	18·3	36·3

N.B.—There are 36 lbs. 11 drs. English, or 40 lbs. Russian to one pood.

* Page 122, vol. 2, Tegoborski's "Productive Forces of Russia."—Longman.

† A reduction was made in the duty in 1853.

Russia is just one of those countries so situated, with regard to the position of its iron mines in one remote corner of its vast possessions, that it has everything to gain and nothing to lose by the introduction of iron from foreign countries, with which it has a cheap and ready communication at many different points. By a vigorous free-trade policy, we cannot doubt that the aspect of the foregoing table might be entirely altered, with the greatest benefit to the capitalists, landed proprietors, and working population.

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Belgium.—As some extracts from the report on industrial instruction in England, made to the Belgian Government in 1853 by M. de Cocquiel, have been translated into English, and published (in May 1856) in the 3rd Report of the Commissioners for the Exhibition of 1851,—and as M. de Cocquiel draws some comparisons between Great Britain and Belgium very different to those which have been made by former writers,—it is the more necessary to state what information we possess from other sources, especially since some of it is derived from the reports of the Belgian inspectors of mines, and ought, therefore, to be reliable.

Belgium, Iron.

Mr. Scrivener remarks (page 240):—"After the peace (1814) the iron manufacture may be said to have recommenced about 1821. In 1822 there was placed at the disposal of the King an annual sum of a million of florins (90,000*l.*) for the encouragement of industry by premiums, loans, and other means. The first object was to improve the method of smelting and manufacturing iron in the mining districts. For this purpose Mr. Cockerill, an Englishman, was invited by the King to settle in the neighbourhood of Liege. He received a very large sum by way of loan in order to assist him in the extension of his works, coupled with a condition that the ironmasters of Liege and Namur should have liberty to go to his works to learn the true principles and the latest improvements in the art. The unremitting industry of Mr. Cockerill formed a large establishment for machinery of every description, in fact, one of the most perfect establishments in Europe.

Mr. Cockerill is alluded to by R. C. Taylor (page 499) in the following language:—"The greatest, the most ingenious of these, Mr. Cockerill, is an example. There was no enterprise originated in which he did not feel himself competent to bear a part. In the last years of his life he showed us the list of the industrial establishments with which he was connected. This list numbered seventy-two undertakings all created upon the grandest scale. This man, to whom his workmen desire

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to erect a statue, has perished, like all men of genius, by the abuse of his principle."

Russia, Iron.

The following table, from Scrivener's "History of the Iron Trade," indicates the remarkable fluctuations which have occurred in the iron trade of Belgium, fluctuations arising, apparently, from the derangements occasioned in commerce by loans from Government in order to develop the iron trade; and secondly, from the establishment of companies (Anonyme) in place of the individual mine owners.

Years.	Make of Pig Iron.	Pig Iron Exports.	Rails.
	Tons.	*Tons.*	*Tons.*
1830	52,500	3,526	—
1836	118,000	6,276	—
1838–9	74,325		
1842	52,500	—	—
1843–4	89,688	—	—
1845–50 average.	152,105	68,353	3,573
1854	200,000	30,000 To France only.	—

The following tables and remarks are extracted from the "Statistique Générale de la Belgique," page 118, Titre iv.:—

Production of Pig Iron.

Year.	Workmen.	Coke Iron.	Charcoal Iron.	Price, Coke Iron.	Price, Charcoal Iron.	Value.
		Tons.	*Tons.*	*Francs.*	*Francs.*	*Francs.*
1845	2,331	121,059	13,504	105	154	14,570,283
1846	3,288	169,389	19,929	130	168	25,508,430
1847	3,716	222,329	26,058	115	160	29,698,403
1848	2,996	142,485	19,096	90	125	15,148,623
1849	2,933	134,511	14,026	83	125	12,898,440
1850	2,755	131,148	13,304	75	124	11,568,857

It results from the above figures that the commercial value of the products of the iron trade in the years 1848, 1849, and 1850, has fallen 37 per cent. below that of 1845, 1846, and 1847, whilst if 1847 and 1850 be compared, the reduction of value has been nearly two-thirds.

The exportation to France of pig iron was only 30,000 tons in 1854,* a little more than the average of that of the

* The total quantity of Belgian tons of pig iron exported to France during ten years, 1841 to 1851, was 277,491 tons, to Prussia 263,739 tons, out of a total exportation of 547,529 tons. During the same period the total exportation of other kinds of iron was 54,085 tons.

10 years ending 1850, so that the exportation of iron from Belgium to France has not at all increased like that of coal in the same period.

During the time of high prices the mean produce of the blast furnaces was 4,000 tons, since the reduction of prices it has averaged 5,600 tons, partly from the system of making white instead of grey iron being adopted, and partly from the stimulus of competition; so that, instead of 50 blast furnaces fed with coke being used in 1846, there were only 25 in 1850. The imprudence and bad financial arrangement of the iron trade between 1845 and 1850 is animadverted upon in the above report of the Belgian Government. It is also noticed, that notwithstanding the diminution of value, and increased make of each furnace, the number of workpeople has not altered in the same proportion, indicating that this portion of the population have been obliged to put up with less regular occupation, as well as with less pay, than they were formerly receiving.

If the views were correct which have been advanced, that the indications of progress in Prussia might be determined by the fact that there the same number of workpeople produced a greater quantity and value than formerly, then the contrary facts observed in Belgium would be an argument of equal value in establishing the retrograde movement of Belgium.

It is singular that neither the United States, France, or Belgium should be producing more iron at the present time (1856) than in 1846-7, whilst in Great Britain and Prussia there is so marked an increase.

Mr. Blackwell seems to think that the production of iron in Belgium in 1855 nearly amounted to that of 1847, but this cannot be thoroughly determined at the present time.

The result of a comparison between the production of iron in Belgium during prosperous years and that of Great Britain, would be, that in 1835 Belgium produced an eighth part, in 1845 a tenth part, and 1854 a fifteenth part, of the quantity manufactured in Great Britain. In 20 years the production of iron in Belgium has doubled, while in the same time that of Great Britain has quadrupled.

The following table represents the statistics of coal, published by R. C. Taylor, from official documents:—

Production of Coal in Belgium. (Taylor.)

1834 . . .	2,443,568 tons.
1838 . . .	3,260,271 „
1844 . . .	4,445,240 „

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Belgium, Iron.

Production of Coal in Belgium, from the "Statistique Générale de la Belgique."—Titre iv. pp. 102, 103.

—	——	Price per Ton.	Value.
	Tons.*	Francs.	Francs.
1845	4,919,257	9.59	47,149,040
1846	5,037,411	9.40	47,419,000
1847	5,664,452	9.23	52,305,000
1848	4,862,707	8.47	41,169,000
1849	5,251,943	7.50	39,494,000
1850	5,820,588	8.0	46,500,000

The per-centage of the increase of coal is, therefore, much the same as that of iron up to 1844; but the ratio of advance has, probably, been higher during the last few years. The comparative exportation of coal to France from Belgium and Great Britain is as follows:—

Years.	From Great Britain.	From Belgium.
1834 . .	56,920 tons.	—
1838 . .	300,470 „	785,440 tons.
1845 . .	557,607 „	1,376,075 „
1854 . .	600,000 „	2,200,000 „

In 1846 a great impulse was given to coal mining in Belgium, by the discovery of some new mines of very considerable dimensions, which will form a source of supply when the mines of Western Belgium may be given up, on account of the cost of getting the coal, owing to the depth of the beds and difficulty of working. This, it was predicted by M. Briavionne, might happen about ten years from the present time.

The mines in Belgium have been under the strict surveillance of officers of the Government; but, probably, owing to the high inclination of the strata in which the coal is worked the accidents have been extremely numerous. (Taylor: Introduction, page 137.) Taking the same number of miners in Belgium and in the northern coal fields of England,†

* Belgian tons of 1,000 kilogrammes.

† Accidents in coal mines:—

——	Ten Years, 1831 to 1840.	Average Number of Miners employed.	Ten Years, 1841 to 1850.	Average Number of Miners employed.
Wounded - -	509	31,500	1,155	47,354
Killed - -	1,016		1,366	
	1,525		2,521	

The per-centage of accidents has therefore slightly increased.

Belgium, Iron.

the proportion of deaths in mines during a period of more than 20 years was 55 per cent. greater in Belgium than in England. Some of the midland coal fields of England would, probably, have shown a less favourable result. The proportion of coal raised, per miner, is also less in Belgium than in England. The only difference between the principle of manufacturing iron in the two countries is the manufacture of a certain quantity of charcoal iron in those districts where wood is abundant. The hot-blast furnace, which was introduced from Scotland in 1836, has become very general; and in Belgium, as in other countries, the mode of manufacturing iron is gradually becoming identical with that of Great Britain. The demand for wrought iron girders enabled the Société Anonyme de Couillet to exhibit some excellent specimens of girders made of wrought iron, of different forms, at the Paris Exhibition; while the use of polished stove pipes has created a demand for very smooth sheet iron, which is excellently rolled in Belgium. There are also specimens of puddled steel made by the Prussian process. Similar as are the general productions of Belgium to those which we manufacture, the manner in which their industries of coal and iron are managed appears to be extremely different. The construction of the works of Cockerill and Co., at Seraing, near Liege, by the aid of Government money, as before related, would prepare us for the expenditure of an enormous sum, and for the lapse of a long period before such an establishment could become self-supporting, if such an event could ever happen. This "model manufactory" of Belgium undertakes entirely the mining of coal and iron, smelting and rolling of iron, together with the manufacture of steel, and machinery of all descriptions. In fact, it is hardly an exaggeration to say that every article in metal, from a pair of scissors to a locomotive, is manufactured in this curious establishment.

In England it is universally admitted that the greatest successes have been achieved by those who have concentrated their attention on perfecting the manufacture of a very limited class of articles; and it is by this means that the art of manufacture has been wrought up to its present standard. It, therefore, appears that the establishment at Seraing is conducted on principles exactly opposite to those adopted by our most skilful manufacturers, and laid down by our best writers on the economy of manufactures. We may learn the system on which other works in Belgium have been conducted from the following paragraph, written by R. C. Taylor in 1847, respecting the collapse of trade which followed the excitement of 1838.

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"Belgium has but just recovered from the effects of excessive speculation, over-production, and the sudden establishment, a few years since, of a vast number of companies for working coal mines before adequate markets could be established. A crowd of new men, adventurers and speculators, without restraint, suddenly appeared, and exposed the honest producers to ruin by their rashness and ignorance. Formerly each worked with his own capital. All this is changed. Agents, having but little personal interest, managed the affairs of societies, justly named 'ANONYMOUS!' Economy did not preside in the formation of these companies. They constructed *superb palaces*, they founded speculations upon exorbitant and transitory prices, and on the day of awakening, they found that they had squandered immense capital, and had created the means of considerable production for an end which it was difficult to attain."

When the crash, similar to our panic of 1825, occurred, it produced an enormously disastrous effect on the production of iron. Out of 58 blast furnaces in existence in 1839, 30 remained out of blast for three years, and were not blown in again until after 1842. The total production of Belgium appears to have fallen as low, at one time, as 52,000 tons of pig iron in a year; an amount only equal to the annual make of one of the moderate-sized ironworks of Great Britain.

Since the iron trade of Belgium has now been for some years in a healthy condition, and has been progressing at a moderate rate, it would be hardly worth alluding to this former want of commercial knowledge and foresight, were it not for the statement made by M. de Cocquiel, in his "Report on Industrial Instruction in England," to the following effect:—

"If the personal qualities of the English are taken duly into account, it will be found that, in reality, that country is not, in an industrial point of view, more advanced than certain nations of the Continent. Our establishments are, beyond any doubt, managed with more order, and in a more skilful manner, than the manufactures of England. Our mines are worked with greater economy, and more in accordance with the laws of science, than those of any other country."

Now, as an impression of a totally different character has been so widely spread through the works of Taylor and Scrivener, based upon the evidence of public Belgian reports, it is unfortunate that M. de Cocquiel does not state the evidences upon which he bases his broad assertion; especially as M. de Cocquiel's "Report" is stated to be the basis of a new law of industrial education in Belgium.

Had it been stated that we had formerly derived great advantage from communication with the Low Countries, we should have agreed with him; for it is perfectly well known that many branches of manufacture now successfully cultivated in England, were introduced, during the Middle Ages, by the Flemings, who, preserving their own language, still form a considerable portion of the Belgian population. In Britain, the Flemings appear to have merged into the general population, except in a part of South Wales, where their villages may still be distinguished from those of their Cymric neighbours, as they adopted the English instead of the Welsh language. In Belgium, also, the Walloons, the descendants of the ancient inhabitants of Belgium, are still distinguishable, both by language and habits, from the other inhabitants of Belgium. Without in the least denying the assistance our manufactures have, in times past, received from these parts of the Continent, (and even in modern times, as regards particular branches of the manufacture of glass,) yet we have always been led to suppose that latterly the current has been settling strongly in the opposite direction. English manufacturers have been invited to settle in Belgium, in order to introduce those great branches of manufacture which they have so successfully cultivated at home; and English engineers and capitalists have constructed several railways, as well as introduced the locomotive into Belgium.

Some improvements in the art of producing particular kinds of coloured glass were brought by a workman named Vincent to Birmingham, soon after the period when the repeal of the high duties on the importation on foreign glass, and of the excise duties, gave a stimulus to the English glass trade. Vincent originally lived at Maestricht, where he became a skilful workman. He then went to Clichy, near Paris. Here, from the fact of his not knowing how to write, it was thought he might be trusted with the processes, which were generally unknown to the workmen employed. He, however, learned to write at an evening school, and then engaged himself to a manufacturer at Birmingham, where he saved several hundred pounds as a workman, and then went into business on his own account. His habits had not been at all adapted for commercial success; he lost his property, was obliged to relinquish his glassworks, and returned abroad.

The art of pressing glass is better understood in England than in any other country. This partly arises from the cheapness of the materials used and of fuel, partly from the skill of the workman and the division of labour, and partly from the fact, that the manufacturer of the moulds has become an independent trade; a better article being produced,

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and at a much cheaper rate than when the glass manufacturer himself produced his own moulds.

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With regard to the smaller branches of metal work, large purchases of arms have been for many years advantageously made in Belgium by English merchants, for the African trade, at much lower prices than they could be bought for in Birmingham. The reason was not that the cost of producing arms was there lowered by the introduction of machinery, but from the extraordinary abundance of manual labour, at excessively low prices, in Belgium. Indeed, it is said, that the detached pieces were not made in factories at all, but carried to the workmen's homes, and finished without the aid of any machinery whatever. Low prices of labour and absence of machinery, or the employment of but rude machinery, often go together, but always indicate an unsatisfactory condition both of commerce and of the labouring population.

The great taste and ability of the French manufacturers, and their liberal expenditure in special tools and patterns, have caused the supply of articles of metal work, where design is an element, to be furnished by France for consumption in Belgium. A large quantity of the best goods manufactured in Birmingham and Sheffield are also exported thither. Indeed, zinc, smelted on a large scale and in an admirable manner by the Belgians, is sent largely to Paris and towns in other countries to be worked up into artistic forms, whence some is returned again in a manufactured state.

As far as manufactures in metal are concerned, it is difficult to imagine any branch to which the description of M. de Cocquiel can apply. The facts on which his observations are based would form *interesting* subjects of investigation to the English manufacturers who may attend the approaching Free Trade Congress in Belgium. At that Congress it will, most probably, be discovered what effect the high duties levied on many articles imported into Belgium, and the premiums given by the Belgian Government on the export of articles of home manufacture, have had on the development of their manufactures, and on the welfare of their working classes.

U.S., Iron.

United States.—The mineral wealth, and its distribution over this immense country, was not well represented at Paris; the English public are, however, well informed on the subject, as they are in possession of the complete reports in connexion with the New York Exhibition, drawn up by Sir C. Lyell and Professor Wilson. Under these circumstances I shall, therefore, only remark that the United States

do not appear to present any exception to the gradual approach to uniformity of process of manufacture which is taking place in every iron producing country; and there does not appear to be, practically, any difference in the plans adopted in the United States and in Europe, except such as are produced by the more extensive employment of anthracite coal, and the more general employment of the gases of blast furnaces for heating the steam boilers attached to them.

The anthracite fuel in the United States is not only abundant, but from its property of decrepitating, when brought to a high temperature, it is found much more suitable for use in the blast-furnace than coal yielding the same ultimate products found in this country. The high price of fuel, and the scarcity of labour, has tended to promote the application of waste gases for such purposes as they could be applied to. The reflection that must naturally arise from a comparison of the progress of iron manufacture in Great Britain and North America will be, that whilst the British production of iron has doubled in ten years, that of the United States, notwithstanding its protective duties, now remains at the figure of 1846, the intermediate period having been marked by an enormous depression. The statistics are as follows:—

Iron manufactured in the United States.

Years.	Tons.	
1832	200,000	Professor Wilson's Report, pages 40 and 42.
1840	315,000	
1842	225,000	
1846	765,000	These figures are given only *as an approximation.*
1847	800,000	
1852–3	500,000	
1853–4	805,000	

The iron produced is of fair average quality, and only in one* locality is there superior iron, suitable for making steel, of really good character. The Americans are excellent judges of steel, and are accordingly large purchasers in the Swedish market of superior iron for their own steel manufacture; and probably imported in 1854 one-third of the quantity of iron from Sweden that Great Britain generally is able to take. The first introduction of the Dannemora iron into America took place during the great depression of trade in England preceding the abolition of the corn laws,† when the consumption of Swedish iron in Sheffield was

* The remark referred to is by J. L. Hayes, of Massachussets, quoted in Dawson's "Geology of Nova Scotia."

† See the list of unoccupied houses in Sheffield in 1841, page 257 of this Report.

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reduced to two thirds of its usual amount, and when a great emigration of Sheffield workmen took place to the United States. We find in America, therefore, as in France, so soon as the steel manufacturers became acquainted with the special properties of the best marks of Swedish iron, a steady demand sprung up for this superior material.

According to Professor Wilson, the American manufacture of steel, at the present time, may amount to 10,000 tons per annum, judging from the number of steel furnaces in existence, always a very uncertain method, as they are not constantly in operation. The following table will indicate the importation :—

Steel imported into the United States.

		Tons.	
In the year 1840	from all countries	2,225	Professor Wilson's
„ 1850	„	6,375	Report, page 46.
„ 1854	from Great Britain only	15,268	English Export List.

The great increase in the consumption of steel (exhibited in the returns of 1854) is probably owing to the prosperity of the railway and agricultural interests; but the demand for this metal has been to a certain degree stimulated by a new and more expeditious mode of producing it. The value of the manganese present in the ores of iron used for the production of steel has been long suspected, but it has only been within the last thirty years that the plan of adding manganese during the smelting process has been discovered and brought into use at Sheffield, and this operation has been found materially to improve the qualities of all but the first-class steels.

By the addition of this metal (manganese) any scrap iron can be run down at a single operation into a steel of common quality, at a cost for melting of from 8*l.* to 10*l.* per ton, the expense of 50*s.* per ton for the intermediate process (of converting bar iron into blistered steel by heating it in a close chamber for many days in contact with charcoal) being thereby entirely saved.

There is no want more felt by the manufacturers of agricultural implements and machinery in all countries, than that of obtaining a material intermediate in price between ordinary iron and the expensive qualities of steel which have been hitherto in use. There are multitudes of purposes for which, if price permitted, such a material might be used. The Americans seem to have taken the lead in substituting steel for iron in agricultural purposes, and, in fact, spades and forks, probably made of English steel, are exported from

the United States to Great Britain, while on the other hand the Germans have been the first to bring into use *steel* cranks, tires, and bells.

Before the use of manganese, all attempts had failed at improving artificially the steely propensities of irons; but now it may be stated that it has improved the *steely propensity or body* of some of the best English irons already equal in PURITY AND CLOSENESS of grain to the lower qualities of Swedish; and that steel made from English iron is now used for purposes for which, a few years ago, it would have been quite unfit. I have already alluded to the exportation to the United States of an iron prepared in Scotland out of Swedish blooms adapted for engraving purposes at a price of 60*l.* per ton; and I am also informed that two-thirds of the expensive Swedish iron sold in New York passes through the hands of Sheffield firms having partners in Sweden, and also in the States. I only mention these circumstances again since so much has been said about the purchases of iron through English merchants having been entirely of low qualities. This idea has probably arisen from the circumstance that the *ad valorem* duty of 30 per cent. charged on foreign iron entering the United States has prevented the consumer from taking so large a proportion of the best qualities as he would, had the duty been a fixed sum per ton.

It has also been thought by the American railway directors to be more important to them to have cheap iron to commence with, and to increase their length of line with the cash saved than to lay out their capital on a very durable iron rail. These are, however, arrangements made entirely by the purchaser in America; and the seller in Great Britain has nothing to do but to execute the order he receives to the price and quality required. That up to the present time he has met the wishes of the purchasers is evident from the following table, if increased demand is any criterion of satisfaction:—Prof. Wilson's Special Report, p. 47, 1854.

Consumption of Iron in the United States.

In the Year.	Manufactured in the States.	Imported.	Where from.	Total.
	Tons.	*Tons.*		*Tons.*
1840	286.903	80,866	From all countries - -	367,769
1847	800,000	—	—	—
1850	564,755	441,514	From all countries - -	1,006,269
1853	} 805,000 {	640,389	From Great Britain only -	1,445,389
1854		519,773	From Great Britain only -	1,324,773

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With a small exception the whole of the iron ore smelted in the States is of native origin. I, however, learnt from Sir E. Logan, the Canadian Commissioner at the Paris Exhibition, that an exportation of magnetic oxide of iron had commenced from mines in Canada to the United States. This ore could be shipped free on board at 5*s.* per ton, and after two trans-shipments could be delivered in Pittsburgh at 25*s.* per ton. Supposing this ore to contain 50 per cent. of iron, this freight (for bringing the ore to the coal) would add 2*l.* per ton to the cost of pig, or 3*l.* per ton to the cost of the bar iron. Such an illustration proves that the success of the ironmaster in the United States does not depend only upon the cost of labour at his works, but also upon the cost of bringing the ore from a distance to the coal, and afterwards of carrying the iron made to the place of consumption. The freight of ore only, in the particular case alluded to, added three times as much per ton to the original cost of the American bar iron as the freight from England has added to the cost per ton of rails made in Great Britain for the new Indian railways; indeed, a contract for the shipment of 150,000 tons has been taken at 17*s.* 6*d.* per ton from England to India.

The addition to the cost of iron arising from freight and duties to America may be seen from the following table, published in 1854; followed by Professor Wilson's views on that important question in America—the supply of labour—which has since assumed a new phase.

"In a recent report from the Secretary of the Treasury, which was referred to the Committee on Finance, the average annual price of iron in the English and American markets respectively for the ten years ending 1853 is given as follows:—

	$	c.
Average of merchants' bar iron at Liverpool	31	78
,, ,, at New York	56	52½
,, ,, at Pittsburg	55	45½
Ditto of best refined iron at Liverpool -	47	64½
,, ,, at New York -	74	50
Average of railroad iron in Wales - -	34	51
,, in New York -	42	20
Ditto of pig iron in Glasgow - - -	13	21
,, in New York - - -	26	72
,, in Pittsburg - - -	26	57

The production of iron for the past year, 1853-4, exceeds that of any former year, and appears to approximate pretty closely upon the total capacity of the furnaces at present in

blast. The stimulus the trade has received from the increasing demand for its produce has already produced some disturbance in the supply of labour, and caused a rise of from 20 to 25 per cent. in its market value. How far labour could be obtained in force sufficient to sustain in the various operations connected with iron making, as mining, quarrying, furnace work, &c., an increase in production in a ratio equal to the increase in consumption remains to be tried. If it could be done at all it could only be effected, I think, by the payment of a much higher rate of remuneration than that at present paid.

In these operations very little skilled labour is needed, while the muscular labour of the immigrant finds an equally remunerative, and at the same time a more congenial employment in developing the surface riches of the mighty west. Thitherward the great mass of immigrant labour moves, and this is only likely to be diverted from its course by the temptation of such a rate of wages as will materially increase the cost of their produce. At the present time a very small number of the men employed in the ironworks are native Americans, the great proportion is either Irish or German; indeed, these two countries appear to furnish throughout the States the subordinate labour in all the various branches of industry."

Since the above was written, the official returns of emigration from Great Britain show that only 103,414 emigrants sailed for the United States in 1855, against 193,065 for that country in 1854. The falling off of emigration to our colonies was equally marked from our own country and also from Germany. There has also been a current of emigrants returning, some successful and others dissatisfied. In consequence of deficient harvests in the eastern States, provisions of many kinds have been as dear in those districts as in England; and employment has been scarce, even at lower rates than in Great Britain. This has happened in a period of unexampled prosperity in the western States, now connected with the Atlantic and lake navigation by lines of railway.

The profits of the iron trade in the eastern States have been small indeed, compared with those investments of money in land in Iowa and such districts in the west, where large tracts have doubled in value annually, and where the small capitalist, who has bought an estate, and mortgaged it at the rate of 30 per cent. interest per annum, has been able, not only to pay the interest, but pay off the incumbrance with the profits of two harvests.

Since the United States take nearly one-half the total quantity of iron exported from Great Britain, we feel almost

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instantly a diminution or increase of the prosperity of any part of that active and energetic community. Indeed, the consumption of iron per man is greater in the United States than in England, and the subject of cheap iron is one that affects the entire population. The high tariff fixed on metals imported into the States is continued, not entirely as it was in France, for purposes of protection, but partly for revenue. The dread of the duty being reduced has always hung as an incubus on the American ironmasters, and prevented capital being embarked in erecting works in situations where, from the abundance of fuel and minerals, iron could be produced under the most favourable circumstances. Indeed, in the iron, as in all other trades placed under care of Governments, instead of being left to their own resources, the manufacturer relies on the Government for his profit and not on his own skill and energy. The extreme cold of winter and excessive heat of summer has also been a drawback, rendering the employment disagreeable, and also materially affecting the earnings of the workman, if paid by the ton, for the labour performed. The reason why the manufacture of iron is conducted by foreigners appears to be, in the first place, because the furnace work requires to be commenced at a very early age, and also needs more confinement in an unpleasant atmosphere than a native American would care to submit to; and in the second place, because the remuneration to workmen and to employers, under a trade fostered by an artificial system of protection, is uncertain, because it is particularly affected by external influences, and exposed to fluctuations, from political and other causes, which cannot be provided against.

Steel.

Steel.

This subject has been already frequently alluded to in connexion with the iron trade, with which it is intimately allied. The art of manufacturing steel commenced in England in the 17th century, but after weighing the evidence carefully, M. Le Play, in his work on the "Manufacture of Steel in Yorkshire," attributes the great stimulus given to this trade in Great Britain to the discovery of the art of casting steel, by Benjamin Huntsmann, a working watchmaker, born in Yorkshire, in 1704, in the course of some experiments in connexion with his own trade. In 1740, induced by the success of his trials, Huntsmann settled at Handsworth, near Sheffield, and established the first factory where cast steel was manufactured for purposes of trade, and which is still carried on by a descendant. Walker and Marshall soon established works in Sheffield and its neighbourhood, but

notwithstanding the new process made but a slow progress; in fact, the art of casting steel, a century after it had been used in England, was stated by a French writer to be, although the best, the least known process in the preparation of that metal. Steel.

At the present time, the revolution in the steel trade, which has been brought about by the memorable discovery of Huntsmann, is entirely accomplished in Great Britain, and a similar movement is every year more strongly felt upon the Continent.

It is, however, since 1835, that the enormous advance has been made in the production of steel in Great Britain and the United States, and which is, therefore, coincident with the development of railways and steam navigation, and their accompanying workshops.

Mr. Unwin, of Sheffield, gives a table of the number of furnaces for the production of steel in Sheffield. There are a few other furnaces in other parts of England which are not enumerated. It is difficult to ascertain whether they are all at full work; but taking, however, 250 tons per annum, as a low estimate of the production of each blistered steel furnace, we can, by these means, compare the French and English productions.

STEEL FURNACES IN SHEFFIELD.

Blistered steel furnaces,	1835	56	Cast steel furnaces,		554
„ „	1842	97	„	„	774
„ „	1846	105	„	„	974
„ „	1853	160	„	„	1,495
„ „	1856	206	„	„	2,113

Comparative production of steel in France and England :—

	France.	*England (Sheffield).*
1835	6,300 tons.	14,000 tons. (Sanderson.)*
1842	9,339 „	20,500 „ „
1846	12,954 „	26,250 „ „
1853–4	14,954 „	40,000 „ „

Consumption of steel in France and England :—

	France.		
	1835. Tons.	1853–4. Tons.	
Steel manufactured in France	†6,300 (Le Play)	14,954 (Sanderson)	
Steel imported into France	1,614 „	413 (British Exports)	
Steel consumed in France	7,914	15,367	

* "Journal of Society of Arts," May 11, 1855, page 456.

† Mr. Porter places the production of steel in France at 2,725 tons in 1836. This must surely refer to some particular description of steel or district, and not to the production of the whole country.

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Steel.

England.

	1835. Tons.	1853–4. Tons.
Steel manufactured in England .	14,000 (Unwin)	40,000 (Sanderson)
Steel exported unwrought from do.	3,100 (Le Play)	20,793 (British Exports)
Steel consumed in Great Britain .	10,900	19,207

Allowing for inaccuracies in these figures, it may be generally remarked that the consumption of steel in France has increased rather faster than in England in the last eighteen years (up to 1853), and the total consumption in the two countries only varies 20 per cent., whilst, if a similar approximate table is constructed, showing the relative consumption of iron in the same countries, very different results will be obtained. It will be as follows:—

France.

	1835.	1853–4.
Pig iron manufactured in France . . .	304,909 tons.	600,000 tons.
Iron imported into France	16,000 „	90,000 „
Iron consumed in France	320,909 tons.	690,000 tons.

Great Britain.

	1835.	1853–4.
Pig iron manufactured in Great Britain .	1,000,000 tons.	2,500,000 tons.
Iron imported into Great Britain . .	20,000 „	35,000 „
	1,020,000 tons.	2,535,000 tons.
Iron exported from Great Britain . .	200,000 „	1,035,000 „
Iron consumed in Great Britain . .	820,800 tons.	1,500,000 tons.

Since I constructed the above tables, Mr. Unwin has kindly furnished me with information, not only of the number of furnaces, &c. in Sheffield, but of those situated in other parts of England, which have not been enumerated in previous statistical returns.

1856.

Production of cast and shear steel in Great Britain:—

In converting furnaces in Sheffield (206) . . .	51,500 tons.
In converting furnaces in other localities in England (54) .	13,500 „
In melting holes used for the direct manufacture of cast steel from iron without conversion in a separate furnace . .	3,000 „
	68,000 „

1856.

Production of cast steel in Great Britain:—

In melting holes for cast steel in Sheffield (2,113) . .	37,834 tons.
In melting holes for cast steel in other parts of England (245) .	4,410 „
Carried forward . .	42,244 „

1856.

Brought forward - - - - - -	42,244 tons.
Shear steel estimated (by the mode of difference) to be produced in England	25,756 „
Total production of cast and shear steel . .	68,000 „

The steel consumed in France has continued for 18 years to be four-fifths of that consumed in Great Britain. The iron used in France was, in 1835, a little over a third of that used in this country. It increased in France in eighteen years to nearly half the quantity worked up in Great Britain. The reasons for such discrepancies in the relative proportions of iron and steel used in two neighbouring countries are not very apparent; they are, perhaps, connected with results produced in France by the political feeling, that France ought not to be dependent for steel (the material of which arms are made) upon any foreign country. On the other hand, the English, rendered apathetic by the duty they levied on Swedish and Russian iron until that was removed, never appear to have suspected that coke iron could be employed for conversion into steel; and, therefore, they drew their supplies of iron for such purposes entirely from Sweden. It is an interesting point in the history of free trade, that until the British ironmaster was thrown upon his own resources, by the entire abolition of any protective duties, he did not make this important discovery. From that time, English iron began to be used for steel purposes, and by recent improvements, both in the preparation of the iron and of the converting process, an amount of steel is manufactured in Great Britain, with coke iron alone, equal to what is produced in France with both French and Swedish iron added together.

By this discovery, the increased demand for steel has been supplied without requiring larger quantities of iron than Sweden had been in the habit of furnishing to Great Britain. It is, however, worthy of remark, that the importation of Swedish iron into the United States, during the year 1854, was nearly double that which took place in 1853. During the same period, the consumption of this metal in Great Britain slightly decreased, whilst the amount used in France was unusually large.

The Swedish trade in iron depends undoubtedly less upon the original cost than upon the superior quality of the iron, which is almost entirely required for conversion into the finer qualities of steel; and no metal has yet been produced in other countries which could in any way replace the valuable material, so much appreciated by the manufacturers of all those nations where the qualities of steel are well understood. The truth

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of this fact has been acknowledged by long experience and after repeated trials. Mr. Sanderson of Sheffield says,—

Steel.

"I estimate the weight and value of the steel made in England (Sheffield) as follows:—

Tons.		£	s.	d.
23,000	of cast steel, all qualities, at 45*l.* per ton	1,035,000	0	0
7,000	bar steel, including German, faggot, single and double shear steel, average 35*l.* per ton	245,000	0	0
10,000	coach-spring steel, 19*l.* per ton	190,000	0	0
40,000 tons.		£1,470,000	0	0

From the foregoing statistics we find that

			£	s.	d.
France	produces	14,954 tons, average value of	443,850	0	0
Prussia	„	5,453 tons, „	170,824	0	0
Austria	„	13,037 tons, „	321,073	0	0
United States	„	10,000 tons, „	212,500	0	0
England (Sheffield)		40,000 tons, „	1,470,000	0	0

Considerable efforts have lately been made to persuade the French public that Algeria can produce iron which will rival that of Dannemora.* Great expectations have been raised, which have, however, been disappointed in the same manner as those which have, at one time or other, been formed by patriotic persons (residing in almost every department of France), as to the eligibility of the minerals of their own neighbourhood to surpass those of Sweden. The hope of enriching their own country, and delivering from its dependence upon foreign supplies this important branch of French industry has been clung to in France with the greatest tenacity.

A similar feeling has prevailed in Great Britain and the Colonies, and with the same result; even during the last twelve years, gentlemen connected with Canada, and interested in its progress, have used exertions of every kind to introduce the Acadian iron (smelted with charcoal in Canada) into regular consumption in the Sheffield market. The promoters of this Company are so much interested in the prosperity of Canada that they do not allow themselves to be discouraged by their present want of success, in obtaining for the Acadian iron a good position in the price current of Sheffield; this price current appears to be the standard by which the value of steel-irons are universally measured, and against which there is no appeal. Indeed, the professor of metallurgy in the Royal French School of Mines, and author of the history of "The Steel Trade of Yorkshire," positively states, after visiting every part of Europe where the industry of this metal is

* The name of the celebrated district where the finest iron in Sweden is found.

carried on, that he has arrived at the conclusion that the price current of Sheffield affords a more precise classification of the different descriptions of iron that can be obtained in any other manner; he has, therefore, published this list in extenso, in the "Annales des Mines de France,"* with the following remarks:— Steel.

"An experience of two centuries at Sheffield, pursued under circumstances of the most active competition, has placed in evidence all the useful qualities of the different irons, while all those causes of error which render it impossible to determine exactly the value of steel-irons, have yielded in time to the prolonged experience of the purchasers."

These errors, which arise from the prejudices of buyers, and from the preconceived notions and private interests of consumers, have naturally neutralised each other. All these disturbing causes being eliminated under the powerful influence of time and experience, there ought only to remain, in the price current of the steel-irons used in Yorkshire, those elements upon which essentially depend the true value of those irons.

Again, speaking of the anxiety felt in all countries to enhance the *steely propensity of iron*† by improving the smelting operations, M. Le Play observes, "All these efforts have remained without any good result. This experience is not only conclusive for the practice of the small factories where the ores of the third class in Sweden and Norway are smelted; but during two centuries the same experiments have been tried on a vaster theatre in the factories of Great Britain and its Colonies, particularly in America and the East Indies. All these experiments have invariably furnished the same result.

"The authors of these experiments, taking their wishes for facts, have almost always stated, in the commencement of their essays, the superiority or the high value of their products. The proprietors of English steelworks, highly interested in the object of freeing themselves from their dependance upon Sweden, have always received with sympathy the hopes that have been conceived by the sellers of iron. The most persevering efforts have been made with a view of establishing the superiority of steel-irons belonging to the British dominions. I have assisted myself, in 1826 and 1842, at the experiments upon different sorts of iron that had been specially produced in England and the Colonies (and particularly in the

* This list is translated in pages 221 and 222 of this report.

† The purity and closeness of grain has been improved. This is a distinct property to that of steely propensity.

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Steel.

south of Hindostan), after attempts continued with that tenacity natural to the English character. All these trials have given some results interesting in a scientific point of view, and of a certain industrial utility; but the fundamental conclusion has always been exactly the reverse of that which the English industry is interested in establishing.

"For it has been proved that those parts of the globe accessible to the commerce of Europeans cannot furnish any iron which, with respect to steely propensity, can compare with the best marks of Sweden."

Tried by the standard of price at Sheffield at the present time, the Acadian iron ranges with the lowest marks of Russian and Sweden, and below the best coke-irons of England. This is attributed by the Company to the fact that Acadian PIG IRON has only been supplied at present, and that when the machinery which has been sent from this country is erected in Canada, the pig iron will be converted into wrought entirely by charcoal; the promoters of the Company hope that then a different result will be met with. We must remember that, even if the quality should improve, the sale for steel purposes will be probably very limited; as, of the great variety of qualities furnished by Sweden, only 24,436 tons were actually consumed in the year 1854. One particular brand, possessing no marked character, can therefore meet with little success in Sheffield. There ought to be, however, room in Canada for the development of some good ironworks, to supply the local wants of the district, and in this manner, it is to be hoped, that the enterprise may succeed. The British Government, it is said, have contracted for Acadian iron for the manufacture of ordnance; we may presume that this is for using in some of the extensive series of experiments which they have in view, to determine from what iron the most perfect cannon should be manufactured. I saw specimens in Yorkshire of Acadian iron, some said to be very good, others bad.

Before leaving the subject of steel, it may be well to remark, that since the most distinguished metallurgists and most eminent chemists in Sweden, have in vain attempted to state the reason of the marked aptitude of certain ores for subsequent conversion into steel, at present, chemical analysis cannot be admitted as a test of the value of iron. Neither have the experiments upon comparative merits of iron for special purposes, undertaken by the French scientific men, given better practical results; the history of the steel trade in France, since the time of Reaumur, in 1720, up to 1835, is one continued series of alternate hopes and disappointments; samples were analysed, experiments were made with

the most favourable results, shares were sold, but Company after Company retired from the trade with heavy losses, and without having even produced a first-rate article; during all this time, the French manufacturers were excelled in quality and distanced in extent of trade by the Sheffield manufacturers, who sent large quanties of fine steel into France, notwithstanding the heavy duties.* Until, at last, in 1835, the manufacturers on the Loire began to purchase the same materials and adopted the same processes which had been invented and carried out by the workmen of Great Britain, men skilled in the practice of their own branch, metallurgy, but without any pretensions to the knowledge of the pure sciences. The proof of the want of relation between ths chemistry of the laboratory and the workshop is, that the workman has been able in this, as in other branches of metallurgy, to detect minute differences which the philosopher has, unfortunately at present, no means of expressing in words. Thus, M. Le Play does not attempt to explain the reasons of the difference between two irons of different sorts, but he refers directly and solely to the price current, which is the index of their commercial utility, and accepts that, without any analysis, as conclusive evidence of their relative superiority or inferiority.

The author of the work already alluded to upon "The Manufacture of Steel-iron"† pays the following tribute at the close of the first part of his memoir to those manufacturers who have been the means of raising the industry of steel to its present high position, both of quality and quantity:—"Constantly occupied to maintain the quality of their own, Swedish metallurgists have wisely resisted the temptation which has elsewhere often cursed the progress of ironworks, to depend upon the economy of fuel; they have always

* Mr. Thomas Smith, assistant-overseer of Sheffield, has given the following information of the population of Sheffield and adjoining parishes:—1801, 45,755; 1811, 53,231; 1821, 65,275; 1831, 91,702; 1841, 110,891; 1851, 135,307; 1852, 143,099; 1853, 150,379; 1854, 157,212; 1855, 161,927.

Houses in the same district:—

—	Occupied.	Empty.	Building.	Total.
1841	22,753	3,223	192	26,168
1851	27,118	267	263	27,648
1852	28,685	499	982	30,166
1853	30,150	594	1,070	31,814
1854	31,522	795	1,293	33,610
1855	34,472	1,568	989	35,029

† Annales des Mines, 4th Series, vol. ix., 1846, page 207.

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understood how to combine attempts at progress with the respect due to tradition. Convinced that the success of the cemented steelworks depends essentially upon the confidence that manufacturers repose in the raw material, they have made all the sacrifices, both individual and collective, that are necessary to a scrupulous preservation of those qualities represented by the distinctive brands of each forge. Thus, for instance, the establishment of the Iern-Vagen, a model institution for all commercial people,* which by a severe control over the quality of the production, guarantees the entire industry of the country against the injury that might be effected by too close an attention to particular interests. It is then to the *intelligence* and *commercial probity* of the Swedish ironmasters, not less than to the *genius* of the Yorkshire manufacturers, that the springing up of this new art is due, which, opening for the future the industry of steel to the capacity of the people of every land, has assisted the promotion of one of the most marked requirements of modern society. This art (the artificial production of steel from iron) has, by a large production of steel of a quality more perfect and more hard than the natural steels, endowed our civilization with means of action proportioned to the energy of the efforts with which it acts upon matter, and to the grandeur of the results that it wishes to attain.

On the other hand, in the jury reports of the French Exhibition of 1849, page 344, we find the practices described which some of those interested in the prosperity of the steel trade in France has most justly condemned, and as this subject (the piracy of English trade-marks on the Continent) has recently engaged the attention of the English public it is important to point out how disastrous this policy has been to those who have adopted it, and to the general standing of French manufacturers in foreign countries.

I have translated the French report as follows:—

Steel Files.

Steel files.

"The fundamental obstacle to the growth of this branch of industry results from the custom adopted by almost all manufacturers of placing false marks on their produce. This deplorable custom is due in part to the desire that unconscientious manufacturers, convinced of their real inferiority, have to turn to their own profit the renown of the best

* This is evidently not the view that would be taken in England. The English are glad to have the opportunity of purchasing iron from Sweden, which is paid for by British manufactures. In England the name of the maker, which is allowed to be used by his successors, is found to be a guarantee as to quality.

Steel files.

foreign manufacturers, acquired by a long succession of talent and honesty; it is encouraged by the retail dealers, who wish to keep manufacturers dependent upon them, and to hinder the consumer from knowing the real marks of steel goods.

"Manufacturers, short of capital, submit in this manner to the terms dictated to them by the dealers, renounce their individuality, and stamp upon their goods such marks as the buyer chooses to order, and even to substitute the name of the retail dealer for their own.

"Another obstacle to the prosperity of the file trade, arises from the inaccuracy of the price-currents published by the manufacturers.

"The history of the English steel trade proves that a skilful manufacturer, who consecrates his life to found the reputation of the trade mark he has chosen, can leave in the sole possession of that mark a large fortune to his descendants.

"The Government will, therefore, render skilful and conscientious manufacturers (the only ones that ought to be encouraged) an immense service in imposing upon each producer the obligation to place his own mark upon his manufactures."

The dependence of the progress of an important branch of industry upon the *probity* of those commercially interested in it is thus shown in a most interesting light by the facts and observations of independent authorities, and places in a conspicuous point of view the feelings of integrity and honour which have alike actuated the workmen and the employers, the buyers and the sellers engaged in producing and dealing in an article where the opportunity for fraud was more easy and less exposed to immediate detection than in any other manufacture.

Copper.

Copper.

M. Le Play, engineer-in-chief of French mines, and professor of metallurgy in the Mining School of France, after having visited all the copper works of the Continent, including those in Siberia, and having made repeated visits to South Wales, for purposes of study, during the last twenty years, has furnished elaborate accounts of every known process relating to the smelting of copper, and has also made the most minute calculations on the cost of each operation, accompanied by a statistical review of the remarkable progress of this industry of Great Britain. These carefully prepared essays will be found in the "Annales des Mines de France" for 1848.

M. Dufrenoy, inspector-general of mines in France, and

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Copper.

deputy chairman and recorder of the jury, class 1, in the Exhibition of 1851, has also published a treatise on the Swedish copper works, in the "Annales des Mines de France" for 1854.

There are thus at the present time most valuable supplements to the account of the process of smelting copper as conducted at the Hafod works, near Swansea, published by the late J. H. Vivian, in the "Annals of Philosophy" for 1823.

Since 1848, when the labours of M. Le Play were concluded, great attention has been paid in Swansea to the separation of the silver contained in the ores of copper. It appears that a German process was first used, which was patented; but since expensive plant, for this purpose, has been erected by different individuals, not only at Swansea and Llanelly, but at Birmingham and Liverpool, it is probable that considerable modifications on the original system have been introduced. The ores containing silver sent to this country are known to have much increased. They are mostly sold by private contract, instead of at the public sales. In 1854, the quantities of copper ore sold by private contract amounted to 24,770 tons, against 220,650 tons, sold at public sale. One principal object of M. Le Play's visits to this country was to ascertain the reason of the extraordinary increase in the amounts of copper smelted in South Wales since 1825. They are as follows:—

	British Copper Ore. *Tons.*	Approximate Weight of Copper extracted from British Copper Ore. *Tons.*
1825	110,613	10,647
1830	150,876	11,904
1835	171,393	15,144
1840	160,763	12,539
1844	171,598	13,213
1847	152,615	11,900
1854	205,706	14,192
1855	216,630	14,484

	Foreign Ore imported. *Tons.*	Approximate Weight of Copper extracted from Foreign Copper Ore. *Tons.*
1825	None	None.
1830	1,437	316
1835	13,945	3,068
1840	42,249	9,506
1844	58,591	13,359
1847	41,490	9,009
1854	50,940	—
1855	58,089	—

Up to the year 1842, although there was apparently a heavy duty on the importation of foreign copper, yet in reality it was often nullified by the permission to smelt, as it were, in bond, the smelter undertaking to re-export an equivalent quantity of copper, and thereby being released from the payment of the duties, which were altered in the following manner from time to time:—

		£	*s.*	*d.*
1809, per ton of ore		0	13	4
1812	„ „	20	13	4
1819	„ „	21	0	0
1825	„ „	12	0	0

In 1842, duties were placed on ore which averaged the amount of 6*l.* per ton on the copper extracted; at the same time, metallic copper imported paid a tax of 8*l.* 15*s.* per ton, and the privilege of smelting in bond was withdrawn. The influence of this direct tax on raw material which was imported from foreign countries, and then re-exported, in the course of a few years appears, with other causes, to have assisted in stopping the rapidly increasing importation of foreign ores, as it gave, of course, a premium of 5 per cent. upon the importation of foreign metallic copper, which could still be imported in bond, and consequently re-exported without payment of duty. In 1851, these duties were almost entirely removed, having produced, in 1849, only 2,292*l.* 14*s.* 3*d.*

The position of the copper trade, in 1854, is shown in the following summary, for the "Mining Records of Great Britain," by R. Hunt, page 31:—

Summary of Copper Value.

	Tons.	*cwts.*	*qrs.*	*lbs.*	£	*s.*	*d.*
Total produce of English mines .	13,042	4	2	21	1,229,807	12	6
„ „ Irish mines .	1,124	13	3	18	128,053	9	6
„ „ Welsh mines .	25	3	3	3	2,010	18	6
Foreign copper sold at ticketings .	3,455	15	0	11	378,498	2	6
Included in private contract sales .	5,426	3	3	14	593,434	0	0
					£ 2,331,804	3	0

The produce of the foreign ores was 16½ per cent. of copper in 1854, whilst that of British ores was only 6⅜ per cent. The per-centage of copper in the 6,351 tons of copper regulus is so great, that probably one ton of regulus produces as much metal as four tons of foreign ore.

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Copper.

Division of copper ores and products containing copper into seven classes, according to the nature of the process by which they are smelted, according to Le Play, page 102:—

1st Class.—Ores containing between 3 and 15 per cent. of copper are calcined in process 1. They are generally sulphurets of iron and copper mixed with a small proportion of oxides. The earthy matter contains, besides some deleterious substances, a good deal of quartz, and a very considerable quantity of sulphuret of iron.

2nd Class.—Ores having from 15 to 25 per cent. of copper, contains less earthy matter than the first class. They are calcined in No. 1, and then passed to No. 5 to be melted with other materials already partly smelted.

3rd Class.—Ores containing from 12 to 20 per cent. of copper, principally in the form of oxide of copper. They are not calcined, but fused in No. 2 along with ores that have been calcined. They contain very little sulphuret of iron.

4th Class.—Ores containing from 25 to 45 per cent. of copper in quartz matrix, containing very little sulphuret of iron. They are composed of oxides of copper of various kinds, associated with very little sulphuret of copper and iron.

5th Class.—Ores from mines, the quality of which is well known, containing 10 to 15 per cent. of copper, and 18 to 24 per cent. of sulphur. They contain no deleterious substances whatever, and are generally sulphuret of copper, with sulphuret of iron and quartz.

6th Class.—Ores from 60 to 80 per cent., exclusively composed of matter free from sulphuret of iron and any noxious substances. They are natural, or artificial sulphurets of copper (regulus), with native copper and oxides combined, with silica and carbonic acid. The matrix is generally quartz.

Besides the above classes, there are the old materials which are produced in such large quantities, the cuttings of copper, the sweepings from the great sheets constantly being rolled. The average of these must contain a very high per-centage of copper.

From results of a smelting work where 47,000 tons of ore were heated in the year, and 6,250 tons of metal

produced, the following table was constructed by M. Le Play (page 105):—

Classes of Ores.	Relative Weight.	Total Weight in Tons of Ore smelted per Week.	Proportion of Copper per 1,000 of Ore.
1st Class, treated in 1 and 2	·790	720·1	0·098
2nd „ „ 1 and 5	·023	21·5	0·228
3rd „ „ 2	·085	77·6	0·182
4th „ „ 3	·081	73·5	0·385
5th „ „ 6	·011	10·0	0·120
6th „ „ 9	·008	7·4	0·662
7th „ „ 4	·002	2·0	0·750
Totals and Means	1·000	912·1	0·137

From the above figures it would appear that the percentage of copper in ores of the year it refers to must have been much higher than at present, viz., at an average of 13½ per cent. Last year the average was only 9 per cent. The high price of copper, and consequent appearance of ores which would not bear transport at former rates, may have affected this to some extent, but the difference appears large.

Copper imported into Great Britain (Parl. Reports):—

—	Copper Ore.	Copper Regulus.	Smelted Copper.
	Tons.	*Tons.*	*Tons.*
1849	46,237	1,196	2,836
1850	40,388	5,473	5,322
1851	35,683	6,442	5,589
1852	37,817	5,226	6,172
1853	45,285	5,107	6,307
1854	50,940	6,351	4,845
1855	58,089	8,510	9,482

Smelted copper and Muntz metal exported from Great Britain:—

—	1849.	1850.	1851.	1852.	1853.	1854.	1855.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
British .	20,480	21,307	17,555	16,936	15,632	13,678	16,658
Foreign	697	990	1,327	1,356	1,705	1,813	1,055
	21,177	22,297	18,882	18,292	17,337	15,491	17,713

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Copper.

Le Play has estimated the production of copper in the whole world, (excepting China,) during the year 1846, at 52,480 tons. The following tables, collected from his works, will approximately represent the production, consumption, and reduction of copper from the ore in different countries, for 1846.—(pp. 560 and 562, Le Play.)

TABLE 1.

	Copper contained in the ore annually raised.	Consumption of Copper annually.	Copper annually smelted.
In the following countries:—	*Tons.*	*Tons.*	*Tons.*
Great Britain	15,800	10,600*	28,600
France	30	9,200	700
Russia	3,900	2,000	3,900
Austria	4,500	2,600	4,500
Sweden and Norway	2,200	400	2,100
German Association	1,500	5,400	1,500
Turkey in Europe and Asia	2,000		2,000
Different European States, around the Mediterranean Basin.	1,100	6,600	800
America, particularly Cuba and Chili.	16,600	6,100	5,900
Oceania, Australia, New Zealand, and Asia (except Turkey, China, and Japan).	2,400	8,300	—
Japan	2,400	1,200	2,400
	52,430	52,400	52,400

The statistics of the copper trade in Great Britain having been noticed, those of FRANCE next claim our attention.

TABLE 2.†

	Consumption of Copper in France.	Quantity of Copper smelted in France.	Copper imported into France.
	Tons.	*Tons.*	*Tons.*
1831			3,080
1836			5,720
1840			8,670
1842	10,597	257	10,340
1845	10,100	520	9,580
1847	8,385	605	7,780

* The Tables pages 260 and 263, indicate that the consumption of copper in Great Britain was in 1855 about 24,000 tons, an enormous increase.

† From pages 586 and 590, vol. xiii. "Annales des Mines," 1848.

TABLE 3.*

TONS of COPPER imported into FRANCE from the following Countries:—

—	Great Britain.	Russia.	Sweden, Norway, Germany, and Low Countries.	Turkey.	Mediterranean States, Switzerland, and Austria.	America.	Other Countries.	Total.
1831	980	1,100	340	130	210	170	150	3,080
1836	1,960	2,310	790	150	230	270	10	5,720
1840	5,330	1,500	410	430	150	830	20	8,670
1842	8,310	400	540	170	70	850	. .	10,340
1845	7,100	460	1,460	10	70	470	10	9,580
1847	3,838	559	1,543	114	195	1,529	2	7,780

Copper.

Almost the whole of the copper ore imported into France was formerly from South America; but since 1846 not only the ancient quarries of Algeria (which furnished such rich materials to the Romans) have been re-opened, but the new mines of this important colony have been surveyed, and many of them successfully worked. Their products were at first sent to be smelted at Marseilles; a spot chosen for introducing the Welsh system of copper smelting, with which the French founders had become well acquainted, through the elaborate researches of Le Play. This system has not, however, yet taken root in France, where the enormous difficulties caused by the complicated system of differential duties, navigation laws, and heavy customs dues, turn trade out of the natural channels, and place obstacles in the way of any branch of commerce which is dependent for success, not only upon manufacturing skill, but upon facilities of regular and cheap transport of the raw material from distant places. On a recent visit to Swansea, I found that notwithstanding the privileges given by the French Government to their favourite colony, Algeria, yet that the ores from that country had begun to arrive at Swansea instead of at Marseilles, where works had been recently established to compete with the Welsh smelters.

It may be here mentioned that M. Le Play had in his calculations understated the quantity of fuel required for the process of smelting. Instead of being 25 cwt. of coal to each ton of ore, it is really 33 or 34 cwt.; and in a district where coal costs 20*s.* per ton, this error adds 13*s.* per ton of ore,—or, reckoning the Swansea average of 11 tons of ore to one ton of metal, 6*l.* 13*s.* per ton of fine copper produced,—to the estimate which has been made of the cost of smelting. Should the average yield of ores now being used in France be, as in Swansea, about 9 per cent. instead of 13¾, the

* From page 586, vol. xiii. "Annales des Mines," 1848.

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calculation made by Le Play, this would make the expense of smelting each ton of fine copper proportionately larger; while, if they should be still richer, that would be in favour of the French manufacture as far as the expense for fuel is concerned.

This is illustrated by a statement given to me by a Welsh smelter who, when the yield of the ores purchased during a whole year averaged 6½ per cent. of copper, found that 16 tons of coal were consumed in producing each ton of fine copper; while in the next year, when the average yield was 9 per cent., he accomplished their reduction with 15 tons of coal per ton of fine copper produced.

The large foreign coal trade of Swansea employs a great number of small vessels, trading to all parts of the world, for which a back freight of ore forms a convenient cargo. The following return of the comparative tonnage of the ships belonging to different countries shows how inconveniently the French smelter is situated, since he can only receive his ore at the low duty when carried in the ships belonging to his own country, the probability being that only one out of twelve vessels sailing from any particular port is French, while the total tonnage of French vessels is only one-eighteenth of the whole mercantile navy afloat.

Nation.			Vessels.	Tons.
Great Britain and Colonies possessed in		1850	34,281	4,232,962
United States	„	1851	. .	3,772,439
France	„	1850	14,354	688,130
Norway	„	1853	4,893	454,856
Holland	„	1850	1,793	390,910
Spain and Colonies	„	1850	7,606	361,401
Greece	„	1850	3,970	264,981
Prussia	„	1849	1,531	265,320
Austria	„	1849	6,083	259,583
Russia (Finland excepted)	„	1849	1,512	251,000
Sweden	„	1853	2,826	249,440
Denmark	„	1852	4,701	245,947
Two Sicilies	„	1850	10,368	221,749
Finland	„	1849	1,375	159,379
Sardinia	„	1850	3,467	159,263
Hamburgh	„	1853	408	123,882

It is a singular fact that Norway, with only one and a half millions of inhabitants, stands the fourth in the scale of maritime nations. The parts of England and France, settled by the Northmen originally, furnish the largest supply of seamen at the present day. Their descendants were also the founders of the mercantile marine of the United States.

The high price of fuel near the coast of France, and the difficulties caused by the artificial system of commerce created by legislation, are probably among the causes which have rendered the new French smelting works less successful, in a commercial point of view, up to the present time than those with us. There are, however, other causes which may help to influence this result: for instance, the climate renders the employment much more disagreeable than in South Wales; the habits of the labouring population are not yet fully formed for this work; and finally, the expenses of management, where companies are concerned, are great compared with those incurred in South Wales, where the factories are managed by those personally interested in them, and worked with capital accumulated in the copper trade itself.

It should be mentioned that there are copper-ore furnaces attached to numerous rolling mills in France, where rich and easily fusible ores are reduced without any calcination, when they happen to arrive, almost as easily as scrap copper. There are works of a similar kind both at Swansea and Liverpool; but a strong distinction must be drawn between these and the Welsh factories, where a great variety of poor and intractable ores are reduced by a system created by a succession of minute practical improvements, the dates and authors of which are unrecorded, but have attracted the warm admiration of Le Play. At Swansea, where enormous sums of money have been spent in experiments, the principal processes of copper smelting now used are precisely those employed forty years ago. Yet, the different characters of the ores lead to daily modifications. There is no absolute rule for the duration of any process, or for the quantity of material that shall be manipulated at one time. The ores, in which an immense number of foreign substances are associated with the metal, are calcined, melted, roasted, refined, and mixed with each other, and with slags produced previously by the workmen, under direction of their foreman, in order to get out the product, fine copper, with the minimum of fuel and labour, and in the quickest time. Practice has rendered the workmen so acute as to appreciate shades of difference in the products of their furnaces, which the chemist, even with the aid of the most minute quantitative analysis, can hardly follow.

Thus Le Play mentions (p. 127), that not more than a three-thousandth part of the fuel used can be detected among the *débris* of the Welsh slag heaps, while (in pages 157 and 158) he sums up the advantages obtained by using the Welsh

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reverberatory furnace (drawn in plate 3, accompanying his text), in the following manner:—

"The air admitted across the fire is the exact chemical equivalent of the solid fuel that is to be converted into gas: in its progress it follows that course which is best suited to the performance of the reactions required, and to the economy of heat; it arrives pure and cold in that part of the furnace where it is to produce an oxidizing flame, the essential object in this operation, and where it ought to prevent the too rapid heating of the material to be operated upon. At last, the air which is not decomposed by the roasting does not arrive at the place where it ought to burn the combustible gas, until it has become highly heated in its slowly ascending movement. The two combustible gases then mutually act under the most favourable conditions, that is to say, after both have acquired an elevated temperature. Finally, the results hereafter described respecting the Welsh system will furnish the best proofs of the perfection of economy that I attribute to this operation. These results demonstrate that the consumption of fuel is three times less than in the other reverberatory furnaces employed on the continent for analogous operations."

I should mention that I believe Le Play has, to some extent, over-estimated the economy of the system of copper-smelting practised in South Wales, in his admiration for this reverberatory furnace, to which he alludes in the following manner (p. 76); after speaking of the importance of finding some use for the small coal, which is often a waste product in the neighbourhood of coal mines,—and pointing to the impossibility of burning non-caking coals in ordinary furnaces, on account of the fuel passing through the bars of the grate:

"Many metallurgists have vainly attempted to turn these materials to better uses. These researches received a new impulse when I had proved, in 1835, that the solid combustibles employed in blast furnaces acted essentially by means of their gasefied products. We all took, as a point of departure for these new experiments, the idea of first converting into gas the fuel in the blast furnaces; and then of conducting it into separate apparatus, to turn its chemical and calorific properties to our profit. The trials of this kind that I have observed in all parts of the continent have not, up to the present time, answered the expectations of their authors. Almost always, the inconveniences resulting from the complications of apparatus have balanced the advantages obtained, and often these trials have ended in pure loss and enormous expense. It is worthy of remark, that at the very period when

we attempted so fruitlessly, and by the aid of apparatus so expensive, to use non-caking fuel in dust (slack) for the fundamental operations of metallurgy, on the continent, by the Welsh founders this problem had been already solved in a manner as simple as it was efficacious. It is, without doubt, to this ingenious discovery that the superiority which they retain up to the present time is due. It would have been difficult for them to have employed, as fuel the saleable coal for which there is so large a demand at such high prices on the shores of the United Kingdom, and on the Continent of Europe. On this occasion, as well as at so many other facts belonging to the history of the industrial arts, we have reason to be astonished, that one of the most ingenious and memorable discoveries of metallurgy has, up to the present time, passed unnoticed, and has not been even mentioned by the British writers on technology. Since the year 1836, the date of my first journey to England, my attention has been particularly directed to the gasefaction of combustibles, and I have noticed the characteristic feature of the Welsh method; but no person could tell me at what period it was introduced into practice in the workshops."

The Welsh furnaces are described and illustrated by accurate plans and sections, at pages 117 and 127 of Le Play's work. Besides their peculiar form and dimensions, he draws attention to the substitution of a thick layer of clinker, along the whole length of the fireplace, for furnace-bars. This mass of clinker is, of course, a non-conducter, and is full of small interstices through which cold air enters the furnace; and while white-hot in its upper surface, it is comparatively cool at the bottom. A few iron bars prevent the whole mass of clinker from falling into the ashpit. The furnace-man keeps the clinker in a proper condition, so as to admit through its substance the exact quantity of air required. The small coal is distributed from time to time over the surface of the clinker, and meeting with the air which enters the furnace entirely through the small apertures of the heated clinkers, is converted at once into carbonic oxide gas; and, caught by the draught of the chimneys, rises over the bridge which separates the fuel from the ore or metal, placed in the same furnace for it to act upon. The carbonic oxide gas then forms a distinct stratum, and occupies the roof or upper portion of the furnace, and burns only at its lower surface, where it comes in contact with the ore or metal, and with an additional supply of oxygen, which converts the carbonic oxide into carbonic acid gas. If this plan of burning slack be so advantageous, it appears remarkable that it should not

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have been extended to other works besides those for smelting copper.

Copper.

The ease with which some of the ores of copper, principally oxides and carbonates, can be smelted, has been already alluded to; and in one of the Swansea works there is no calcining furnace at all, the ore being simply roasted, melted, and then refined. There is also a variation in the plans, according to the class of copper that is to be produced. Thus, in a factory I visited, where the object was to make cake-copper for rolling and hammering, Cornish ores were used, and these were sorted in definite proportions previously to being calcined. In another factory, the best selected copper was required for conversion into yellow or Muntz metal. This necessitates the production of a purer description of metal than ordinary cake-copper, and the process of smelting is modified by the introduction of an extra process. In this, the property that metals, such as tin, lead, antimony, nickel, &c., (which may be accidentally associated in the copper ores,) possess of being more readily reduced, is now taken advantage of, by the smelter. The *matt*, or regulus, of copper is exposed to a temperature sufficient to reduce a *small* portion of the copper, and almost *all* the other metals present. The contents of the furnace are then run out into ingots, when the metallic portions, being heavier than the oxides or sulphurets which form the *matt*, fall to the bottom of the ingots of metal. The two portions separate readily, on cooling. The matt forms the upper part of the ingots, and the inferior metal is contained in the bottoms. The matt will furnish, in the next operation, what is called "best selected copper." The bottoms are sold at a much lower price than either the tough-cake, or the best selected copper, and are used for various founding purposes, but are not pure enough to roll.

Dr. Percy found that, sometimes, by remelting with charcoal tough cake-copper which had rolled hot perfectly well, it lost the property of rolling. This may have something to do with the reduction of the sub-oxide, the presence of which Mr. Dick has so clearly demonstrated, or it may have been owing to minute portions of silicon or phosphorus obtained from the charcoal. If this latter be the case, then the notion of the copper-smelters may be correct, that the addition of foreign matters in the proportion of only one in 10,000 parts of copper may prevent copper from working properly. These are details upon which it is to be hoped, metallurgical chemists may be able to give further information. Dr. Percy's description of the actual practice is much more simple than

Copper.

that given by Le Play. Thus, Dr. Percy, in his lectures, treats the process as *one* of *six* operations only. On the other hand, Le Play describes *two* distinct processes: one process consisting of *six*, and the other of *ten* operations. These are represented in plate 3, one of the series of excellent drawings of furnaces, &c. which illustrate his work on South Wales. A full description is given, in that remarkable work of everything which Le Play supposes to happen, under the separate heading which is appropriated to each operation. A table of reactions is given at page 514; and of cost from page 526 to 555.

This latter account seems to have been constructed upon data which are not usually met with, and is therefore not strictly applicable to the present time. The difficulties of ascertaining the cost of copper smelting, by adding together the presumed expenses attending each operation, are obviously very great; and even if the cost could be ascertained of each operation, that would not give the average cost in a manufactory where the duration and expense of the process are continually being modified to meet the requirements of the class of ores about to be worked. Dr. Percy disposes of the subject of cost by simply stating that Mr. Logan, an old copper-smelter of great experience, told him, that the following may be taken as a general rule, ten shillings per ton, and two shillings for every one per cent. per assay.

It must be remembered that copper ores can be reduced and converted into fine copper at a single operation; but they are found to be more economically treated by reduction in a series of six or more operations; and that the modifications introduced in practice are not deviations from the principle of the process. The advantage of subdividing the operations is dependent upon the facility obtained for watching the results of each; and being able, by means of the knowledge thus acquired to treat the material in subsequent operations to the greatest advantage.

Since the economy of labour in the Welsh factories and the superiority of their system, have been quoted by foreign writers as models for imitation in works of wide circulation, it may be well to notice the perfection of the system of inspection adopted in South Wales. However delicate may be the operation of calcining ores, there are other operations still more difficult, where, indeed, the want of skill or care on the part of the work people offer still more inconvenience. The performance of the calcining process is therefore necessarily confided to the young workmen, who thus enter on their course of metallurgical labour. The employment of an inexperienced staff gives reason to apprehend negligence of

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work, which might disturb the subsequent operations of the foundry. So, in order to prevent this as much as possible, the workshops are always placed under an elderly workman, whose duty it is to frequently visit the furnaces, during both day and night. A glance thrown upon the current of flame would be sufficient to inform this inspector of an irregularity in the state of the clinker or of the furnace; and of the temperature acquired by the ore, and by the walls of the furnace; for, since the process always commences at a fixed hour, the inspector is taught by his own experience whether the labour has been too quickly or too slowly performed. This facility of control is one of the principal advantages of the Welsh system, as it constantly excites those workpeople to work well who would not be sufficiently induced to do so by the sense of duty.

Nickel.

Nickel.

This valuable metal has entered into much more general use since the discovery of electro-plating. It was formerly exclusively obtained from Germany, and principally from the Kupfer nickel ore. A large supply of nickel is at the present time derived from the Eisen nickel ores, extensively worked at Espidals Vœrk, four days' journey from Christiana, Norway, by an enterprising firm whose smelting establishment is at Birmingham. These gentlemen also possess a method of separating in a pure form by an economical process nearly the whole of the nickel and cobalt from the iron and copper with which it is associated.

This method discovered by an eminent metallurgical chemist is not patented, but kept strictly private.

That it is not one readily found out may be surmised from the fact that for centuries similar ores were smelted solely for the cobalt they contained, which is used extensively as a pigment for earthenware, and in the fine arts. The nickel, thrown away as valueless, is now worth 6*s*. per lb.; when alloyed with copper and zinc it is called German silver, and can be sold at proportionately low prices. Twelve per cent. of nickel is now said to be an ordinary mixture. Mr. Topping, who was one of the earliest manufacturers of German silver, on retiring from business, published the result of his experience. The packfong, or Chinese white copper, is also an alloy of nickel, copper, and zinc, and is supposed to be obtained from a mineral containing ores of all these metals in combination, and not to be manufactured like our German silver, by uniting three metals together while in a metallic state. It is, therefore, possible that the Chinese may never have seen pure nickel. We know that zinc (spelter) was only

discovered in the eighteenth century, probably in the year 1741, by Henkel; although ores containing zinc and copper were worked from the time of the Romans, to produce brass, a compound of copper and zinc. This metal possesses all the good qualities of copper in hardness and malleability, and in addition possesses a beautiful white colour resembling silver. This is important, because in the old method of plating, a thin ingot of silver was welded on each side of a thick ingot of copper, and then rolled into sheets. Metal plated in this manner could not be deeply chased or engraved; and great difficulties existed in manufacturing elegant designs, as every part had to be made out of sheet metal, it being impossible to cast ornaments, riffle and chase them, and then plate them afterwards (except by the leaf silver process, which had no durability).

Nickel.

Nickel is the least abundant of the useful metals. Its commercial value is due to its ductility and non-corrosive or non-oxidating properties; and when alloyed with copper and zinc, as forming a substitute for silver, under the name of German silver or argentine. It is also considered superior to steel for the manufacture of some philosophical instruments, as it does not (except when heated) readily oxidize.

The ores or minerals containing nickel are the oxide, sulphuret, arseniuret, arsenio-sulphuret, antimonio-sulphuret, arseniate, arsenite, and silicate of nickel. It is also associated with some ores of cobalt, as the arseniuret; but the separation of it from the cobalt ores is one of difficulty, and requires nice manipulation.

Of the above mentioned ores, the most abundant or commonly occurring ore is the arseniuret or Kupfer-nickel, of a greyish metallic red appearance, and containing about 40 parts of nickel and 50 of arsenic in the 100 parts, mixed with a little cobalt, iron, and sulphur. Copper nickel accompanies cobalt, silver, and copper in the mines of Saxony; it is also found in Thuringia and Styria, and, but sparingly, at St. Austle in Cornwall, and in Scotland on the Duke of Argyle's property.

According to Professor Dana, it is found associated with smaltine in gneiss, at Chatham, Connecticut. Nickel ores are also worked somewhat largely in Norway. The arsenio-sulphuret and antimonio-sulphuret are also used; the former is obtained at Helsingland, Sweden, and also near Harzgerode in the Hartz.

M. S. Gueymard has recently discovered the arseniate of nickel associated with blende (sulphide of zinc) in the Department of the Isère, France, in strata, probably, of Jurassic

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age; and also the antimonio-sulphuret of nickel in the mountains of Valbonnais, Grenoble.

Nichel.

The use of nickel, as before stated, is chiefly for the manufacture of German silver, which consists of eight parts of copper, three of nickel, and three and a half of zinc. The alloy, under the name of "white copper," has long been used in Saxony; and a similar compound is employed in China, from whence it is exported to the East Indies, where it is known by the name of *packfang*.

The white copper of China, which has the colour of silver, and is very sonorous, consists, according to M. Murer, of copper, zinc, nickel, silver, and a trace of cobalt and iron. It is much valued in China, where it is considered to be worth about a fourth its weight of silver.

Different manufactured articles are now electro-plated with nickel, by precipitation of the metal from the solution of the sulphate.

It appears that an Act was passed in the reign of William III., for the prevention of the *blanching* of *copper* in imitation of silver, and which probably alluded to the German silver in use at that period.

Monsieur Karmarsch of Hanover (one of the jurors of the French Exhibition), remarks in a letter dated 11th of January 1856:—

"In every part of Germany there are manufacturers of German silver (which we call neu silber), the larger ones of which make the nickel metal from the ores. Such is the case also in Austria and Saxony, from whence the other manufacturers buy the larger part of the nickel they require. The cobalt ores are principally found in Saxony, and in the same parts as those of nickel (viz., at Schneeberg and Freiberg), in Bohemia at Joachimsthal, Thuringia at Saalfeld, Hesse at Riechelsdorf, and Biber in Styria at Schladming, and in Hungary. The smalt, almost the only article made of these ores, is manufactured in Saxony at Schneeberg, Aue, and Zochopau, Bohemia at Platten, and Presnitz, Westphalia, at Heorst, &c. In the kingdom of Hanover and its neighbourhood there are neither cobalt or nickel ores, nor manufacturers of either article."

Platinum and Palladium.

Platinum and Palladium.

Platinum, until 1843, was employed for the coinage in Russia, but has been latterly withdrawn from circulation, for what reason does not appear, since the only other purpose for which it is used is for making chemical vessels, and these could not

consume more than 2,000 pounds or 3,000 pounds weight per annum, its price in ingot being about 1*l.* per ounce.

Platinum and Palladium.

It is an interesting metal, as it resists, like palladium, the action of heat, and cannot be melted at all while in a pure state. Platinum is found native in granular pieces, which are welded together and rolled into ingots, thence into sheets, and afterwards worked by hammering into the required form. The whole of this process is performed by Desmoutis, Chapuis, and Co., of Paris, and by Johnson, Matthey, and Co., of London.

The French exhibition of platinum is remarkable for the great size of the retort, its being raised out of one sheet instead of soldered at the bottom, and also for its attached tube being made without any seam. Johnson and Matthey exhibit a retort of a different form to any previously used, and which they say has been highly approved by a sulphuric acid maker, who is now working a similar one. They state that after fifteen or twenty years, platinum, by use, loses one fifth of its weight, probably from the action of impurities in the acids boiled in it, and requires frequent repairs with gold solder. They observed that these patches of gold were perfectly untouched, and have therefore welded an ingot of gold upon the platinum, so that when manufactured, the interior of the pan should have a surface of gold. There is also a platinum retort exhibited by Benhams and Froud, such as has been used in commerce for many years.

It is remarkable that the exhibition of platinum work should be so remarkably good, considering the small extent of this industry. The smallest of the three retorts was worth 700*l.*

Platinum, when polished, has something of the external appearance of tin; while palladium closely resembles lead. In the Exhibition, by Desmoutis, there was a large cup of this latter metal marked 17,600 francs.

It appeared to be only made to indicate the capabilities of the metal, as its leaden colour rendered it unsuitable for any purpose to which the precious metals are applied. Palladium is sold at 5*l.* per ounce for alloying with silver and copper. The mixed metal is sold to dentists at the rate of thirty shillings per ounce.

I have the honour to be, &c.

ALFRED TYLOR.

On certain Optical and other Instruments.—By Sir David Brewster, K.H., F.R.S., Vice-President of Jury for Class VIII. Sir David Brewster on Optical Instruments.

To the Right Honourable the Lord Stanley of Alderley, President of the Board of Trade, &c. &c.

St. Leonard's College, St. Andrew's,
8th March 1856.

My Lord,

In drawing up a report on certain optical instruments and apparatus exhibited at the Paris Exposition, for the information of your Lordship and the Board of Trade, I labour under a difficulty of having no diagrams to illustrate my descriptions, and of having only that kind of information which is derived from a personal examination of the instruments and articles exhibited. Had drawings and descriptions of these been communicated to the members of the Jury, or published since the adjudication of the medals, I should have been able to speak more confidently of the ingenuity of the exhibitors, and of the value of their labours.

The instruments which I propose to describe may be arranged as follows:— Instruments, &c. to be described.

I. The Telescope.

eflecting Telescopes.

1. Lord Rosse's telescope.
2. Mr. Lassell's telescope.

Achromatic Telescopes.

1. Lerebours' great telescope.
2. Steinhill's telescopes.
3. Secretan's equatorial telescope.
4. Messrs. Chance's large discs of glass.
5. Daguet's discs of glass.

II. Achromatic Microscopes.

1. Mr. Ross's microscopes.
2. Messrs. Smith and Beck's microscopes.
3. Oberhauser's and Pillischer's microscopes.

III. Optical Apparatus for Lighthouses.

IV. Stereoscopes.

V. Kaleidoscopes.

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VI. Photographic Cameras.

VII. Optical Apparatus for Physical Researches.

1. A solar telescope, by Dollond.
2. Arago's polarimeter, by Duboscq.
3. Lithoscope for distinguishing precious stones.
4. Brunner's refractometer.
5. Steinhill's refractometer.
6. Telescope for measuring distances.
7. Herapath's artificial tourmalines.
8. Varley's graphic telescope.
9. Duboscq's polariscope.
10. Arago's interference refractor.

VIII. Instruments for Scientific Instruction.

1. Duboscq's regulator of electricity.
2. Nachet's multocular microscope.
3. Nachet's binocular microscope.
4. Foucault's pendulum.
5. Ouviere's uranoscope.

I. The Telescope.

The telescope.

Of all the machines and instruments of human invention, there is none so remarkable in its theory or so startling in its revelations as the telescope. It enables us to see what would for ever remain invisible. It displays to us the existence of bodies which we can neither see, nor touch, nor taste, nor smell, and it exhibits to us forms and combinations of matter whose very existence even the wildest imagination never ventured to conceive.

The improvement of such an instrument has therefore called forth the highest powers of genius, and almost every natural philosopher, from the time of Galileo to that of Lord Rosse, has sought for fame in bringing it to perfection.

The Reflecting Telescope.

Reflecting telescopes of Gregory and others.

Although the refracting telescope, formed by glass lenses, was the first form of the instrument, and enabled Galileo, Huygens, and Cassini to make important astronomical discoveries, yet from various causes it was, in the time of Newton and his contemporaries, superseded by the reflecting telescope first proposed by James Gregory, and improved by Newton, Hadley, Hawksbee, Short, Herschel, Ramage, and Lord Rosse.

Large telescopes not exhibited in Paris.

Owing to the great size to which reflecting telescopes had attained, it was impossible to exhibit them in the London or Paris Exposition, and it was therefore only in models that they

could be submitted to the examination of the juries. To the Exhibition of 1851 no model of a reflecting telescope was sent, but in the Paris Exposition very fine models of the reflecting telescopes of the Earl of Rosse and Mr. Lassell were submitted to the juries.

Models of them exhibited.

Owing, perhaps, to these great instruments appearing only in models, no medals were awarded to the two distinguished astronomers who exhibited them; but we are disposed to think that this was a mistake, seeing that the object-glass of the great telescope in the Imperial Observatory, by Lerebours, received, what it well merited, one of the Medals of Honour. Considering therefore these telescopes as having been exhibited in the only manner in which it was possible, it is necessary to give a brief account of them.

1. *Reflecting Telescope of the Earl of Rosse.*

Lord Rosse's largest telescope;

Having overcome the great practical difficulties which had been experienced in casting metallic specula of a large size, Lord Rosse succeeded in casting one fully *six feet* in diameter, and which, when ground and polished by machinery of his own invention and construction, had a focal length of *fifty-three* feet. For this large speculum, weighing nearly four tons, a tube was provided, *eight* feet wide in the middle and fifty feet in length, consisting of deal staves hooped like a cask. The speculum itself was fixed in a large cubical wooden box about eight feet in each side, in which there is a door, to allow two men to go in, in order to remove or replace the cover which protects the speculum. This box is fastened to the end of the tube so as to form the lower end of it, and contains an ingenious contrivance for keeping the speculum from moisture by absorbent materials. In order to prevent the speculum from breaking or changing its form, very ingenious and effective means have been provided.

machinery for moving it;

This enormous tube, through which I have walked when it was in a horizontal position, is established between two walls of castellated architecture, about sixty feet high, so as to enable the observer to examine the heavenly bodies for about half an hour before and half an hour after they pass the meridian. The machinery for moving it, and the galleries for observation, along with the telescope, weigh twelve tons; and this mass of matter is very ingeniously balanced by counterweights suspended by chains fixed to the sides of the tube. The galleries for observers hold twelve persons, and strangers are not a little startled when they find themselves suspended midway between the piers over a chasm sixty feet deep.

discoveries made by it.

With this gigantic instrument the most important discoveries have been made. The great and startling fact of

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spiral nebulæ—the resolution of nebulæ into stars—the duplication of stars hitherto reckoned single, and remarkable structures on the moon's surface are among the achievements of Lord Rosse's telescope.

2. *Mr. Lassell's Reflecting Telescope.*

Mr. Lassell's reflecting telescope;

The principle of construction of the twenty-foot equatorial, originally erected at Starfield, is precisely the same as that of the nine-foot equatorial described in the twelfth volume of the Memoirs of the Royal Astronomical Society, and engraved in plates V. and VI. of that volume.

its tube;

The tube is of sheet iron, barely a tenth of an inch thick, 20 feet long, and 25 inches inside diameter, united by rivets with the heads inside, so that the outside is smooth and apparently without seam. Its weight is 594 lbs.; the square box or casting which encloses the tube is 5 ft. 6½ inches long, 2 ft. 3½ inches in the side, and weighs 992 lbs. The *uprights* are 7 ft. long, and 3 ft. wide at the base, each weighing 450 lbs. The cone and large circle to which the uprights are bolted are in one casting, and weigh about 2,010 lbs. The speculum is 24·1 inches diameter, 240 inches focus, and weighs about 380 lbs. There are, indeed, three specula belonging to the telescope, of the same diameter and focus, but varying in thickness from about 2·4 to 2·8 inches.

speculum;

The speculum is mounted in a sort of skeleton box, the back of which is of wrought iron, 0·28 inches thick, and when in its place, it exactly fills the end of the tube. The box or plate is held in its place in the tube by three strong equidistant screws tapped into it, and revolving in collars attached to three brackets screwed to the tube, so that these screws having square heads fitted with a key, command the perfect adjustment of the speculum at all times, without interfering in the least with the manner in which it is supported.

method of supporting the speculum;

When the telescope is pointed near the zenith, the speculum is supported entirely by the back of this box, which receives the three ultimate points of a system of levers, dividing the back of the speculum into eighteen portions of equal area. As the telescope, however, is depressed from the zenith, it is evident that the pressure of the speculum on these levers must begin to be transferred to its lower edge, which, if suffered to rest on any hard substance, would immediately begin to produce distortion. To prevent this, in some degree, the speculum has its lower half resting upon a broad, thin, semicircular hoop, secured at the ends of a horizontal diameter by stout brackets attached to the circumference of the supporting box. This hoop is nearly as broad as the speculum, and not thicker than a piece of ordinary

card. Some distortion is still perceptible at low altitudes, by the pressure even of the upper part of the speculum upon the lower, and another system of levers for preventing flexure in this position is also attached to the supporting plate. These take up the support as the others yield it, and render the speculum capable of retaining its normal figure in all positions.

systems of levers employed;

An exact description of both systems of levers (which would occupy too much space here) will be found in the Report of the British Association, Edinburgh, for the year 1850. Mr. Lassell had not then constructed this second system of levers, but he immediately afterwards carried out the plan there proposed, with so slight a variation as not at all to affect its principle, or vitiate the description. Instead of incurring the labour of casting a new speculum with ribs on the back, he cemented a number of blocks upon the back of the speculum, which serve as bearings for the ends of the levers, and have this advantage over the proposed ribs, that they are so disposed as to be out of the way of the levers for vertical support—an essential condition. He has found twenty-seven levers to be sufficient; the long and short arms being in the proportion of about 12 to 1, and loaded with about a pound weight at the end. As this is a most important and efficacious arrangement of the mode of supporting a large speculum, one of the models exhibited at the Paris Exposition was a full-sized *exemplar* of this method of support.

moved by a clock;

The equatorial is driven by a clock-movement, which is abundantly powerful, and goes sufficiently well to keep a star apparently immovable in the field, but would scarcely suffice to keep it bisected by a wire for more than perhaps a minute.

a Newtonian finder employed;

The finder of the telescope is a Newtonian reflector, of 4·3 inches aperture, and 42 inches focus, carrying a magnifying power of 27 times. This sort of finder is more convenient than an achromatic one, as it shows objects in the same relative positions as in the great telescope, however it may be directed. It is very essential for the convenience of observing, and especially for the right performance of the telescope, that the mirror should always preserve the same relative position in respect to its movement in altitude being in a plane perpendicular to the horizon, and this is secured by wheel work attached to the cast-iron box containing the telescope, which rotates the tube, and secures the horizontality of the axis of the eye-tube in all positions of the telescope.

glass prism used in place of a plane speculum;

Instead of a plane speculum, Mr. Lassell generally uses a prism, which transmits a pencil two inches in diameter, and is therefore just large enough to include all the rays reflected by the large speculum. It was made for Mr. Lassell by

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M. Merz, of Munich, and is of admirable quality, no test that has been applied being sufficient to reveal any imperfection. The only inconvenience in its use is that on very dewy nights it will scarcely retain its full brilliancy, more than from an hour and a half to two hours, after which period it must be taken out and wiped. This trouble is, however, less than might be expected for, having two prisms, each mounted in a frame, which by means of steady-pins can be instantly placed so that the prism shall be in exact adjustment, not more than two or three minutes is occupied in exchanging the prisms.

magnifying powers used;

Mr. Lassell possesses an almost unnecessary variety of magnifying powers, positive and negative, as well as single ones, which include the following powers, 160, 219, 260, 297, 316, 366, 430, 479, 565, 614, 628, 650, 760, 778, 864, 1,018, 1,027, and 1,292. The usual powers for the planets *Saturn*, *Uranus*, and *Neptune* are 316, 479, 565, 628, and 650, though, while in Malta, he frequently used with advantage 778 and 1,018.

discoveries made by it;

Among the very important discoveries which Mr. Lassell has been enabled to make with this telescope may be mentioned the satellite of Neptune, an eighth satellite of Saturn (*Hyperion*), discovered also simultaneously by Mr. Bond in America; the re-observation of *Mimas*, the closest of Saturn's satellites, on several occasions, notwithstanding a very wide opening of the ring, which renders the detection of so minute and close a point a matter of extreme difficulty. Mr. Lassell discovered also *Ariel* and *Umbriel*, the two closest of the satellites of Uranus; in addition to such a series of observations of the planet's system as makes it extremely improbable that more than two others (*Titania* and *Oberon*) have hitherto been ascertained to exist.

new satellites in Saturn, Uranus, and Neptune;

transparency of the obscure ring.

The remarkable fact of the transparency of the obscure ring was likewise discovered by Mr. Lassell during his temporary residence in Malta, and independently by Captain Jacob, at Madras.

A more detailed account of these several different discoveries will be found in the monthly notices of the Astronomical Society of London.

Superiority of England to other nations in reflecting telescopes.

With the telescopes of Lord Rosse and Mr. Lassell, now described, and with those of Sir William and Sir John Herschel, the great astronomical discoveries which illustrate the last century have been chiefly made; and though England has fallen behind other European states in the construction of the achromatic telescope and other instruments, she stands unrivalled, both in the Old and New World, as the inventor and the improver of the reflecting telescope. In acknowledging the truth of this opinion, foreign nations will justly

express their surprise that these gigantic instruments have sprung from private liberality and enterprise, and, with one exception,* without any encouragement from the Sovereign or the nation.

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The Achromatic Telescope.

The achromatic telescope, in which the object glass is composed of one or two convex lenses of crown glass, and a concave one of flint glass, was invented by an English country gentleman, Mr. More Hall, and also by John Dollond, an English optician. During more than half a century, foreign nations were supplied with this instrument as made by Dollond, Ramsden, and other English artists; but owing to the difficulty of procuring proper flint glass, and the severity of the English excise laws, which prevented artists from improving it, the manufacture of achromatic telescopes has passed into foreign workshops, and England deprived of a valuable source of employment and of revenue.

Achromatic telescope invented by More Hall and Dollond.

In the English Exhibition of 1851 the exposition of achromatic telescopes was limited both in their number and size. Mr. Simms exhibited achromatic object-glasses, whose apertures were 9, 8, 7, and 4 inches: the largest of these was entirely of English manufacture, the discs, both of flint and crown glass, having been made by Messrs. Chance, of Birmingham: in the other object-glasses the flint lenses only were of foreign manufacture. Mr. Andrew Ross exhibited a fine achromatic telescope, 3 feet in focal length, and with an object-glass $2\frac{1}{2}$ inches in diameter, for which, and his microscope, he received a Council medal. MM. Buron† and Lebrun, of Paris, M. Kinzelbach, of Wurtemburg, and M. Busch, from Prussia, exhibited some excellent telescopes, but with apertures not exceeding *four* inches.

Achromatic telescopes exhibited in 1851.

At this time there were in Great Britain three magnificent telescopes of French manufacture, and with apertures of *twelve* or *thirteen* inches, which, had they been exhibited, or shown in model, would have defied competition. One of these instruments, by M. Cauchoix, has done valuable work in the observatory of Mr. Cooper, at Markree Castle, in Ireland; another, by the same artist, in the observatory of Sir James South, has, by circumstances beyond his control, been doomed to inglorious rest; while the third, the Northumberland telescope, has been usefully employed by Mr. Challis in the Cambridge Observatory.

Cauchoix's achromatic telescopes in England.

* To the munificence of George III. we owe the great telescope of Sir W. Herschel, with the four-feet speculum.

† One of M. Buron's telescopes had an object-glass of rock crystal, which was found to be very good.

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Achromatic telescopes of greater interest still, and of great variety, have been exhibited in the Paris Exposition.

1. *Great Telescope of M. Lerebours.*

Great telescope of M. Lerebours.

M. Lerebours exhibited the object-glass of the great achromatic telescope of the Imperial Observatory of Paris. The flint glass of this admirable object-glass, 39 centimètres, or about 14 inches, in diameter, was obtained, about twenty years ago, by the younger Guinand from the glass-works at Choisy le Roi. M. Lerebours' father began to grind it in 1836, but after several fruitless attempts with crown glass of a bad quality, though the best which could be obtained, he abandoned the work. He executed, however, before his death, which took place in 1840, an object-glass 12 inches in diameter, and which was perfect, with an aperture of 10½ inches. This object-glass is now in the possession of M. Secretan, the successor and former partner of the present M. Lerebours.

Having obtained, in 1843, from M. Bontemps, at the glass-works of Choisy le Roi, two discs of crown glass, M. Lerebours resumed the construction of his object glass of 14 inches, and he succeeded in completing it at the commencement of 1844. During the year 1845 and 1846 it was frequently tried and examined by MM. Arago, Mathieu, Laugier, Faye, and Goujon, and at the beginning of 1847 M. Arago advised the French Government to acquire it for the Observatory. M. Salvandy, then Minister of Public Instruction, after some delay, agreed to purchase it for 40,000 francs (about 1,670*l.*) Fifteen days afterwards the French revolution broke out, and the arrangement came to an end. Annoyed by these untoward events, M. Lerebours offered it to the Board of Longitude for 25,000 francs (a little more than 1,000*l.*), a sum scarcely one half of its cost. The offer was accepted, and the telescope is now the finest in the Imperial Observatory. A medal of honour was adjudged to M. Lerebours for this object-glass.

2. *Dr. Steinhill's Achromatic Telescopes.*

Dr. Steinhill's achromatic telescopes;

Various telescopes of the common size for ordinary purposes were exposed in the Paris Exhibition, but by far the most valuable instruments were exhibited by Dr. Charles Augustus Steinhill, of Munich. These telescopes, the largest of which had an object-glass of 6½ Paris inches in diameter, made of the glass manufactured by M. Daguet, of Soleure, were not only fine instruments, but were also remarkably low in price. In those which I had occasion to examine, the distinctness of vision was very great, and the secondary

spectrum inconsiderable. Dr. Steinhill gives a greater focal length to his object-glasses, in relation to their aperture, than had previously been done, and he is thus enabled to diminish indefinitely the detrimental effects of the secondary spectrum, when high magnifying powers are used in viewing very bright objects. In a comparison of one of Fraunhofer's best instruments, 34 lines in aperture, and 42inches in focal length, with one of his own, 27 lines in aperture and 45 inches in focal length, Dr. Steinhill found that, with its highest power of 126, Fraunhofer's surpassed his; but when both were used with eyepieces that gave a magnifying power of 210 and 225 respectively, Dr. Steinhill's telescope showed small dots (defects in a printed page), which were invisible in Fraunhofer's instrument. Upon reducing, however, the aperture of the latter instrument to 28 lines the dots were seen.

their excellence;

These object-glasses of great focal length, beside diminishing indefinitely the secondary spectrum, are much more economical. An object-glass, with 4 inches aperture, 100 inches focal length, a magnifying power of 500, and giving a perfectly black background to a very bright object, can be had for 200 florins (16*l.* 10*s.*), and with tubes and eyepieces, for less than 300 florins (25*l.*) In order to obtain the same results with the usual object-glasses, one of 6 inches would be required, which would cost from six to eight times as much.

Dr. Steinhill's object-glasses are made of the glass of M. Daguet, of Soleure. Its homogeneity is carefully tested, and its refrangibility accurately determined for the rays B, C, D, F, and G. The spherical aberration is rigorously corrected for the whole object-glass from its centre to its margin, which cannot be done by spherical surfaces. The following are the apertures, focal lengths, and prices of Dr. Steinhill's mounted double object-glasses. Each of the object-glasses of the greater focal lengths will bear an eyepiece of one-fifth of an inch equivalent focal length, so as to give a magnifying power five times the focal length expressed in inches in the second column of the Table.

their size and price.

Aperture, in French inches.	Focal length, in Paris inches.	Prices.			
		Florins.	English Money.		
			£	*s.*	*d.*
6	3 and 4	4	0	6	9
30	30, 36, 48	43	3	12	0
48	48, 60, 95	200	16	10	0
60	75, 120	377	31	4	0
72	96, 160	627	52	4	0
84	124, 192	970	80	0	0
96	144, 216	1,386	115	0	0

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3. *M. Secretan's Equatorial Telescope with a Clock movement.*

Secretan's equatorial telescope;

This beautiful instrument is *thirteen feet* in focal length, and its object-glass has a real aperture of *nine and a half inches*. The polar axis is *sixteen feet four inches* long, and is formed of six bars or tubes, traversed by strong straps of iron bolted to their two extremities, and strengthened by numerous rods of polished steel between them, which form a very rigid prism. There are two prisms of this kind, each composed of three principal rods, between which the axis of the telescope is supported, so that it can move freely in a complete circle between them, in order to take every position in declination.

The circle of right ascension, which is placed on the platform that receives the clock movement, is two feet in diameter, and shows seconds of time by means of two verniers. The clock movement has a fly regulator, and a weight made so as to render the clock independent. The circle of declination has a level fixed to the eye-tube, in order to give the optical axis its proper altitude. The illumination near the eye-glass is obtained from a lamp kept vertical in every position of the telescope.

its micrometer.

The telescope is furnished with a micrometer having *eight* fixed wires, *five* in one direction, and *three* perpendicular to the five, and also with two moveable parallel wires independent of each other. The motion of one of these is reckoned upon a graduated circle, which counts up to forty revolutions. The other performs the part of a fixed wire, and can be placed in any part of the field. The whole micrometer has a motion round the optical axis of the telescope, so as to enable the observer to measure the angle of position. This motion is measured by a circle divided into minutes, and is furnished with a clamp and endless screw.

The object-glass of this equatorial, which has been tried for three months at the Imperial Observatory, and found to be excellent, is about to be purchased by the Government. The instrument is still the property of M. Secretan, M. Leverrier having ordered from him another possessing certain specified properties.

4. *Messrs. Chance's Discs of Flint and Crown Glass for Achromatic Telescopes.*

Messrs. Chance's discs of glass;

Among the most remarkable and valuable products of British manufacture exhibited in Paris, we must rank the gigantic discs of glass from the works of Messrs. Chance Brothers and Company.

These articles consisted of two kinds of crown glass, and three kinds of flint glass, the latter varying in specific

gravity from 3·2 to 3·8, in order to answer the various purposes for which they were wanted, for cameras, telescopes, and microscopes.

their gigantic disc of 29 inches;

The largest of these discs was a pair of flint and crown, *twenty-nine inches in diameter!* The flint glass disc was exhibited in the Crystal Palace in 1851, and obtained a Council Medal. Since that time I have entertained the hope that the English Government would purchase these discs, and construct with them the grandest achromatic telescope that was ever contemplated by the most sanguine astronomer: and with this object in view, I brought the subject under the notice of persons of high position, and influence, but the only individual who took any interest in the subject was the Earl of Ellesmere, who liberally offered to give several hundred pounds to assist in the purchase of the glass, and the construction of the instrument. In the hope that private munificence might supply the means which national parsimony had refused, I was occupied with a scheme of acquiring for British Science the power of extending widely its boundaries, when I received the mortifying intelligence that M. Leverrier, alive to the interests of science and the glory of his country, had in his possession the Birmingham discs, and had entered into an arrangement, dependent on their excellence, to purchase them at a high price for the French Government for the construction of a telescope.

about to be purchased by the French Government.

Messrs. Chance exhibited also a pair of 20 inch discs for photographic purposes, another pair of 16 inches for telescopes, and a great variety of smaller ones from 9 inches downwards to 1 inch.

5. *Daguet's Discs of Glass.*

Very fine discs of flint and crown glass from 16 inches downwards, and prisms of the same materials, were exhibited by M. Th. Daguet, of Soleure, in Switzerland. This glass is in high estimation among foreign opticians, and its maker was honoured with a Council Medal at the Exhibition of 1851. At the French Exposition a Medal of Honour was adjudged to M. Daguet for the discs of glass which he exhibited.

Daguet's discs of glass.

II. Achromatic Microscopes.

The achromatic microscope, an instrument of modern invention, and of the most extensive use in the arts and sciences, has, from the spirit of competition excited by the London and Paris Exhibitions, been brought to a high degree of perfection. In the Crystal Palace of 1851

Achromatic microscopes.

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description of those in the Crystal Palace of 1851;

Mr. Andrew Ross, Messrs. Smith and Beck, and M. Nachet of Paris, were the leading competitors. Mr. Ross and Messrs. Smith and Beck received Council Medals, and M. Nachet a Prize Medal. The instruments of the two first artists were of first-rate quality, and those of M. Nachet were superior to those of all foreign opticians. The following tables show the relative angles of aperture and focal lengths of the object-glasses exhibited by the competitors:

Mr. Ross's Object-Glasses in 1851.

Mr. Ross's;

Focal lengths.	Angles of Aperture.
1 inch	27°
$0\frac{1}{2}$ „	60°
$0\frac{1}{5}$ „	113°
$0\frac{1}{8}$ „	107°
$0\frac{1}{12}$ „	135°

Messrs. Smith and Beck's Object-Glasses in 1851.

Messrs. Smith and Beck's;

Focal lengths.	Angles of Aperture.
$0\frac{2}{3}$ inch	45°
$0\frac{4}{10}$ „	70° to 75°
$0\frac{4}{10}$ „	60°
$0\frac{1}{5}$ „	100° to 105°

M. Nachet's Object-Glasses in 1851.

M. Nachet's.

Focal lengths.	Angles of Aperture.
$0\frac{1}{5}$ inch	88°
$0\frac{1}{8}$ „	108°
$0\frac{1}{18}$ „	134°

Mr. Ross intended to exhibit in Paris object-glasses of a still higher order than those which we have mentioned, and he would thus have found himself in competition with his eminent rivals Messrs. Smith and Beck and M. Nachet. He was prevented, however, by the pressure of business from exhibiting the new object-glass, which he had prepared for that purpose; and Messrs. Smith and Beck, who had no English rival, carried off the microscopic prize by receiving a Medal of the First Class. Although the microscope of M. Nachet was not equal to that of the English artists, it had such a high degree of merit, that a Medal of the same value was adjudged to him.

Medal of the First Class adjudged to Messrs. Smith and Beck at the Paris Exposition.

Oberhauser's microscopes.

MM. Oberhauser, of Paris, exhibited an excellent achromatic microscope, and also one intended for observations in the vacuum of an air-pump, for which a Medal of the First Class was adjudged.

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Mr. Pillischer, of Bond Street, exhibited a microscope with an achromatic object-glass half an inch in focal length and of such excellence that a Medal of the Second Class was awarded to him. Mr. Pillischer also exhibited what he calls a lenticular microscope, for examining urinary deposits at the bedside, which has been highly spoken of by the late Mr. Golding Bird and Mr. Queckett.

Mr. Pillischer's microscopes; the lenticular microscope;

Mr. Pillischer's "student's microscopes" were remarkable, not only for their cheapness, but the excellence of their construction. The following is a list of the angles of aperture and prices of his object-glasses:

the student's microscope.

Focal lengths.	Angles of Aperture.	Prices.
2 inches	14°	2*l.* 2*s.*
1 „	26°	2*l.* 2*s.*
$0\frac{1}{2}$ „	60°	4*l.* 0*s.*
$0\frac{1}{4}$ „	90°	5*l.* 0*s.*
$0\frac{1}{5}$ „	109°	5*l.* 0*s.*

The following Table contains a description of the Achromatic object-glasses which Mr. Ross intended to exhibit:—

Mr. Ross's new Object-Glasses in 1855.

Mr. Ross's newest object-glasses.

Object-glasses. Focal lengths.	Angles of Aperture.	Magnifying Powers with four Eye-pieces.				Prices.		
		A.	B.	C.	D.	£	*s.*	*d.*
2 inches.	12 degrees.	20	30	40	60	3	0	0
1 „	15 „	60	80	100	120	2	0	0
1 „	22 „	60	80	100	120	3	10	0
$0\frac{1}{2}$ „	65 „	100	130	180	220	5	5	0
$0\frac{1}{4}$ „	85 „	220	350	500	620	5	5	0
$0\frac{1}{4}$ „	125 „	220	350	500	620	7	10	0
$0\frac{1}{8}$ „	135 „	320	510	700	910	10	0	0
$0\frac{1}{8}$ „	130 „	400	670	900	1,200	11	0	0
$0\frac{1}{8}$ „	150 „	400	670	900	1,200	12	0	0
$0\frac{1}{12}$ „	170 „	650	900	1,250	2,000	18	0	0

Messrs. Smith and Beck sent two achromatic microscopes to the Paris Exposition, namely, one of their very best instruments, and another of an entirely new construction, to which they gave the name of "the Educational Microscope."

Messrs. Smith and Beck's microscopes;

The first of these microscopes differed very little from the one which they exhibited in 1851 at the Crystal Palace. It

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had, however, object-glasses of a shorter focus and greater angular aperture, as is shown in the following list:—

Focal lengths.	Angles of Aperture.
$1\frac{1}{2}$ inches.	13°
$0\frac{2}{3}$,,	27°
$0\frac{4}{10}$,,	90°
$0\frac{1}{5}$,,	110°
$0\frac{1}{8}$,,	120°

their educational microscopes.

The *Educational Microscope* exhibited by Messrs. Smith and Beck is an instrument of great value, and from its low price and excellence it cannot fail to have an extensive sale. With object-glasses of one inch and a quarter, and apertures of 22° and 75°, its price, packed in a case is only 10*l.*, and the additional apparatus, including one Lieberkhuan, a Wenham's parabolic reflector, a Wollaston's camera lucida for drawing, and a polarizing apparatus complete, with prisms and selenite, amount only to 5*l.* additional. Since the middle of 1855 no fewer than 100 of these Educational Microscopes have been sold, and two-thirds of this number had the additional apparatus.

Fine microscope shown to the Jury by M. Amici.

When the Jury of Class VIII. were comparing the rival microscopes, M. Amici, of Modena, distinguished by his optical inventions, showed a microscope which exhibited certain striæ in test objects better than any of the instruments under examination. This superiority was produced by the introduction of water between the object and the object-glass; but as M. Amici was not an exhibitor, the Jury was not called upon to adjudicate to him a Medal.

M. Nachet's object-glasses.

The following were the object-glasses which M. Nachet exhibited in 1855, and which were much admired by the Jury:—

——	Focal Lengths.	Angles of Aperture.	Prices.
			£ s. d.
No. 3.	$\frac{1}{4}$ inch.	75°	2 10 0
No. 4.	$\frac{1}{6}$,,	90°	2 10 0
No. 5.	$\frac{1}{8}$,,	95°	3 3 0
No. 6.	$\frac{1}{10}$,,	110°	4 0 0
No. 7.	$\frac{1}{14}$,,	125°	5 5 0
No. 8.	$\frac{1}{18}$,,	165°	7 5 0

With these two last object-glasses, M. Nachet states that there is no test object too difficult to be resolved when it is plunged in Canada balsam.

III. Optical Apparatus for Lighthouses.

Optical apparatus for lighthouses.

Polyzonal lenses, or lenses composed of separate pieces having a common focus, were 40 years ago recommended by by myself as peculiarly adapted for lighthouses; and their introduction into the Scottish lighthouses in place of the old parabolic reflectors was pressed upon the Engineer and the Commissioners of the Northern Lights before Fresnel had submitted them to the French Lighthouse Commission. I persisted for many years in urging the Trinity House and the other Lighthouse Boards to adopt this great improvement. The Scotch Board at last authorized me to get one of the dioptric lenses constructed in London. It was executed in flint-glass by the Messrs. Gilberts; but nothing farther was done in the matter till Mr. Alan Stevenson was sent by the Board to Paris in 1834, for the purpose of comparing the dioptric lights, which had so long been guiding the mariner on the French coast, with the parabolic reflectors used in Britain. The result was such as had been long before pressed upon the Board and the British public,* and the new lenses have been partially introduced into Scotland, England, and Ireland. Much, however, remains to be done; and as Messrs. Chance and Company have an establishment where the dioptric apparatus can be manufactured to any extent, the Board of Trade could not perform a greater service to humanity, and to the commercial interests of our mercantile navy, than by extinguishing every parabolic reflector on our shores, and replacing them by the new lenses.

First polyzonal lens made in England;

manufactured by Messrs. Chance;

In 1851 Mr. Wilkins exhibited a lighthouse apparatus executed in Paris, of St. Gobin glass, by M. Letourneau, and at the same time Messrs. Chance and Company exhibited another of a similar kind.

by M. Letourneau

At the Paris Exhibition of 1855 the Minister of Agriculture, Commerce, and Public Works exhibited a catadioptric lighthouse apparatus of the first order, with eclipses every minute, constructed by M. Henry Lepaute, under the direction of MM. Leonce, Reynaud, and Degrand. A Great Medal of Honour was adjudged to the Administration of Lighthouses, and a Medal of Honour to M. Lepaute for this beautiful apparatus.

by M. Lepaute;

Another lenticular apparatus was exhibited by M. L. Sautter and Co., who received a Medal of Honour from the jury.

by M. Sautter and Co.

* See Edinburgh Review, April 1833 and April 1835, vol. lvii. p. 169, and vol. lxi. p. 221, for an account of the British Lighthouse System.

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M. Blazy Jaliffier exhibited various pieces of apparatus for lighthouses, and for lighting town clocks and railways, and was rewarded with a Medal of the First Class.

M. Blazy Jaliffier's apparatus for lighthouses.

Medal of the First Class adjudged to Messrs. Chance.

The same honour was conferred on Messrs. Chance and Company, the only British exhibitors of lighthouse apparatus, for their catadioptric light of the first order. In the quality of the glass, either in reference to colour or freedom from striæ, and in the fitting up of the various parts, this apparatus seemed to be very little, if at all inferior, to its rival. Its glass seemed to be somewhat whiter than the French glass, having a slight tinge of yellow, that of the French glass having a tendency to blue.

IV. Stereoscopes.

Stereoscope;

first constructed by Mr. Elliott and Mr. Wheatstone.

The fundamental principle of the stereoscope, that in seeing objects in relief we unite the two dissimilar pictures produced by the right and left eye, was known to Galen, Aguilonius, Porta, and others. The first person that seems to have thought of constructing an instrument for uniting two such pictures was Mr. Elliot, of Edinburgh, but he did not publish his invention. Mr. Wheatsone, in 1838, communicated to the Royal Society of London, and was the first to publish, an account of an apparatus called the stereoscope, for uniting two dissimilar pictures, and thus producing solidity or relief. This apparatus consisted of two reflecting mirrors, and is known by the name of the *reflecting stereoscope*. To another form of the stereoscope invented by myself, and now in universal use, I gave the name of the *lenticular stereoscope*, from its consisting of half or quarter lenses, which magnified while they combined the dissimilar images.

Lenticular stereoscope.

First exhibited in 1851.

Only one stereoscope, namely a *lenticular* one, was exhibited in the Crystal Palace of 1851. It was made by M. Duboscq, of Paris (from a model one which I had given him in 1850), and formed part of his fine collection of philosophical instruments.

Although the stereoscope is known principally as an instrument of amusement, it has claims upon science and the arts of no ordinary kind; and the time is not distant when it will be regarded as an indispensable auxiliary in the education of the people.

Stereoscopes exhibited in the Paris Exposition.

A great number of stereoscopes, besides the one exhibited by myself, were sent to the Paris Exposition. M. Claudet, Mr. Williams, of Regent Street, M. Duboscq, and Mr. Millet exhibited hexagonal stands with six stereoscopes, which were visited by crowds of spectators. Messrs. Lefort, Queilhe, Lamiche, Warren Thomson, and Dejonge also exhi-

bited stereoscopes, and MM. Couppier, Moulier, and Soulier produced admirable binocular slides for the instrument.

V. Kaleidoscopes.

Kaleidoscopes.

Although the kaleidoscope has been long used both in England and on the Continent, for creating patterns for carpets, and for analogous purposes in the decorative arts, it is generally regarded as an instrument of amusement.

Bate's kaleidoscope, with metallic reflectors.

The kaleidoscopes which I was requested to exhibit in the Paris Exhibition were two in number. The *first* was a very fine instrument, constructed with much care by the late Mr. R. Bate, optician, London. It consisted of reflectors of speculum metal, which could be set at various angles which were the aliquot parts of a circle.

Universal kaleidoscope for obtaining patterns.

The *second* was an *universal kaleidoscope*, constructed so that by a piece of ingenious mechanism the reflectors could separate round an axis and give circular patterns, or take a parallel position at various distances to give rectilinear patterns, or converge to a centre at any required distance, so as to produce curvilinear patterns of any radius of curvature.

Telescopic kaleidoscope.

No specimen was exhibited of the *telescopic kaleidoscope*, its most interesting form, in which objects at any distance, living or dead, at rest or in motion, can be introduced into the figure or pattern.

VI. Photographic Cameras.

Photographic cameras of 1851; M. Ross's camera;

In the English Exhibition of 1851, various photographic cameras were exhibited. That of Mr. Andrew Ross with two lenses, about three inches in aperture, was considered the best. In this instrument the foci for the chemical and luminous rays were united, and the spherical aberration was carefully corrected for central and oblique pencils. A remarkable camera, with two achromatic lenses eight inches in diameter, was exhibited by a French artist, M. Plagniol, but the size of its lenses was its principal recommendation.

M. Plagniol's.

During the last four years, great improvements have been made in the photographic camera, and much ingenuity has been shown in its adaptation for taking binocular pictures. Cameras have also been made for the use of travellers, in which the photograph can be developed and fixed without resorting to a dark apartment.

Voightlander's camera;

Among the most eminent improvers of the photographic camera, M. Voightlander, of Vienna, occupies a distinguished place, but he has not exhibited any of his instruments either in the Exposition of 1851 or 1855.

those of other artists.

In the Paris Exhibition several photographic cameras were exhibited by the English opticians, Messrs. Horne and

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Thornthwaite, and by Mr. King, of Bristol, who received a Medal of the Second Class; and by the French opticians, M. Jamin, M. Ch. Relandin, and M. J. G. Schiertz.

M. Jamin's camera object-lenses.

M. Jamin, who received a Medal of the Second Class, exhibited several fine object-glasses for photographic cameras. He constructs them of three kinds; 1st, on what is called the German system, with two object glasses; 2ndly for landscapes, and according to the wish of the purchaser, either for rapid operation or for pictures of a large size; and 3rdly, for landscapes and portraits. The following is a list of the sizes and prices of the larger object-glasses.

Size of Object-glass.	First System. Price in Francs.	Second System. Price in Francs.	Third System. Price in Francs.
Inch. parts.			
1 7	20	16	35
2 3	40	25	80
3 0	90	50	140
4 0	300	120	350
5 0	500	200	550
6 0	700	300	800
7 0	900	450	1,100
8 0	1,200	600	1,500
14 0	5,000	2,500	5,500

Large lenses useless in taking portraits.

However creditable it is to the ingenuity and enterprise of the artist in executing lenses of such magnitude and value as most of those in the preceding list, it is very difficult to appreciate the advantages which are expected from them. If we require to take a photographic landscape with singular rapidity, or in twilight, a large lens is absolutely necessary. If our object is to take a large picture, it may be taken with a small camera, and afterwards enlarged by an enlarging instrument, and therefore a large lens is by no means necessary for this purpose. The only advantage of large lenses, which would justify an artist in increasing the expense of them, would be in taking almost instantaneously the portraits of animals.

In taking the portraits of human beings such lenses are worse than useless. I have proved, both from theory and experiment, that such portraits so taken are monstrous representations of humanity, even when the lenses have an aperture of *three* or *four* inches. With an aperture of *fourteen* inches the human face would be the most vulgar caricature.

M. Jamin exhibited also another photographic object-glass with new properties. It was what he calls a double combined one, with the optical and chemical foci coincident,

and was furnished with a *cone centralisateur*, which is said by the Abbé Moigno to add considerably to the distinctness and to the prompt fixing of the pictures. It has also a variable focus, and may be used either for landscape or portraits. With this lens M. Disderi took colossal pictures nearly 30 inches high by 21 broad.

M. Jamin exhibited also three sets of lenses of great perfection, and of all curvatures, made of crown glass, flint glass, and rock crystal, and also a fine set of prisms of all sizes and forms.

VII.—Optical Apparatus for Physical Researches.

Apparatus for physical research exhibited in 1851.

In the Exhibition of 1851 several important instruments for carrying on researches in different branches of physical optics were exhibited by French opticians, and none whatever by British artists. M. Duboscq exhibited the beautiful heliostate of Silberman by which a solar ray reflected into a dark room remains fixed during the greater part of the day;—the ingenious saccharimeter of M. Soleil for determining the quantity of saccharine matter in any solution;—the haloscope of M. Bravais for exhibiting the phenomena of halos and parhelions; the polarimeter of M. Arago for measuring degrees of polarisation, and the lenticular stereoscope of which I had communicated to him the construction. M. Duboscq exhibited also Arago's apparatus for showing the interference of polarised light, Babinet's goniometer and Fresnel's screw for producing by compression the polarising structure in glass.*

Apparatus exhibited in Paris.

The Paris Exposition contained many ingenious instruments for prosecuting researches in physical optics. One of the most important of these was,—

1. *A Solar Telescope.*

A solar telescope.

This instrument, which was exhibited by myself, was constructed for my use, at the expense of the Royal Society, by the late Mr. Dollond for the purpose of examining the deficient lines in the solar spectrum. For several years I had been engaged in this inquiry with an achromatic telescope by Ramsden, and a prism executed by the late distinguished optician, M. Fraunhofer of Munich. As the part of the spectrum under examination necessarily consisted of homogeneous light, it occurred to me that an achromatic object-glass was unnecesssry, and that an object-glass more suitable for the

* So early as 1817, Colonel Colby constructed and presented to me a powerful screw with which I made my experiments in the compression of glass and minerals.

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purpose required to be corrected only for spherical observation. The object-glass was therefore composed of two lenses of plate-glass, of which the curvatures were obtained from Sir John Herschel's formula, and the eye-glasses were made on the same principle. The focal length of the object-glass is 3 ft. 6 inches; the diameter of the object-glass, 4 inches; the height of the large prism executed by M. Merz is 3 inches, and the three sides of its horizontal triangular section, 5 inches, 4·45, and 3·7. Several cylindrical lenses, which have a peculiar action in rendering visible faint lines in the spectrum, and a large hollow prism for holding oil of Cassia and other fluids, accompanied the instrument. Its sides were equal, and 8 inches in length.

Great prism by M. Merz of Munich.

2. *Arago's Polarimeter.*

Arago's polarimeter.

This instrument, intended to measure the polarisation of the atmosphere was exhibited by M. Duboscq in his fine collection of optical instruments in the Crystal Palace of 1851. It consists of two parts, not easily explained without diagrams, one of which is to measure the degree of polarisation of the sky at any point to which the instrument is directed, and the other to determine the altitude of that point above the horizon. The first consists of a bundle of glass-plates, 6 inches long, and 1¼ wide. This bundle has a motion round the axis of a graduated arch, which measures the angle of incidence of the light reflected from its surface, when its degree of polarisation is balanced by the opposite polarisation of the bundle of plates. This angle affords, by a well-known process, a measure of the degree of polarisation required. The point of compensation, or the angle at which the polarised light of the sky is reduced to common light, is ascertained by a polariscope with a doubly refracting prism at the eye end, and a piece of rock crystal at the other, which exhibits none of the polarised colours by common light. Another aperture in the polariscope, close to the piece of rock crystal, and receiving directly the compensated light, enables the observer to compare the whiteness of its two images with the whiteness of the other two.

Arago's polarimeter.

Polarimeters employed by the Reporter.

In the polarimeters which I employed in the three years observations* from which I determined the form of all the lines of equal polarisation in the atmosphere, as published in Johnston's Physical Atlas, I employed the ingenious polariscope of Savart, and measured the requisite altitudes with a common quadrant. The determination of the point of compensation does not require nicely divided instruments.

* Memoirs of the Royal Irish Academy, vol. xix. part 2.

3. *Lithoscope for discriminating Minerals.*

Lithoscope for discriminating minerals, precious stones,

This instrument was constructed for me by the late Mr. Dollond, and exhibited for the first time at Paris. Without noticing the ingenuity of the artist in fitting it up, it may be described as a small rectangular prism placed horizontally above, and upon, the polished surface of a precious stone or mineral. A drop of one or other of three or four oils having the least and the greatest and intermediate refractive powers, is placed between the lower and larger surface of the prism and the upper surface of the stone. The film of oil being a parallel one, the images of a small candle or disc of light reflected from the common surface of the oil and prism, and the common surface of the oil and stone, are coincident; but if by a means of a screw at one end of the prism we lift up that end, we convert the film of oil into a prism, and the two images separate. The brightness of the image reflected from the glass and the oil is a constant quantity for that oil, and the comparison of it with the brightness of the image reflected from the oil and the stone, enables us to tell which of the precious stones we are examining. We can thus, at a single glance, determine whether the stone is diamond, ruby, sapphire, or only glass. Different fluids may, in like manner, be distinguished.

and fluids.

4. *Brunner's Refractometer.*

Brunner's refractometer.

The object of this instrument is to measure with great accuracy the index of refraction of doubly refracting crystals and other bodies. Our countryman, Dr. Blair, first used accurately divided instruments for this purpose. Mr. Brunner, the Troughton of Paris, has produced an instrument of great beauty and accuracy, which without diagrams it is impossible to describe. Being a juror he received no medal.

5. *Steinhill's Refractometer.*

Steinhill's refractometer.

This instrument, constructed by Mr. Becker, Newman Street, London, and exhibited by him, was invented by Dr. Steinhill. It consists of two prisms formed by two plane parallel glasses and one plane convex lens. Both prisms are filled with distilled water, and the cross wire of a micrometer is made to bisect a platinum wire, when the index is at *zero*. One of these prisms is then emptied and filled with another fluid, whose index of refraction we wish to ascertain. The wire no longer bisects the platinum wire as before, and when they are brought again into bisection by the micrometer screw, its divided head will give a measure of the deviation of the wire produced by the larger refractive power of the fluid

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in comparison with water. This instrument gives measures equal to the $\frac{1}{4000}$ of an inch.

6. *Telescope for measuring Distances.*

Telescope for measuring distances.

This instrument, intended for military purposes and for a *coming-up glass* at sea, was exhibited by myself, and was constructed by W. Harris, optician, in London. A pair of wires or points absolutely fixed in the field of view in the focus of the eye-glass nearest the eye was opened and shut optically by the motion of a second object-glass to or from the first, and the change of angle was indicated by divisions engraven on the tubes. In another form of the instrument a divided object-glass which gave double images was made to move to and from the main object-glass, and thus to vary the angle subtended by the images. A patent was taken out by me for these instruments in 1812.

7. *Herapath's Artificial Tourmalines.*

Herapath's artificial tourmalines.

These very interesting crystals, to which the name of *Herapathite* has been given, was discovered by Dr. William Herapath, of Bristol, and were exhibited in the Paris Exposition. They are intended to supersede plates of real tourmaline and Nicol's prisms, which have been hitherto used in experiments and researches on the polarisation of light. These plates are thin crystals of the sulphate of iodo-quinine, and so completely do they absorb one of the pencils produced by double refraction, that two transparent plates, scarcely thicker than gold leaf, are totally impervious to light when crossed at right angles. Dr. Herapath has obtained them more than six-tenths of an inch broad. These delicate plates are preserved between two thin plates of microscopic glass, interposing a film of an ethereal solution of Canada balsam. The process of making them is so simple that Dr. Herapath has often prepared a dozen good artificial tourmalines in an hour, and he remarks, "that before long these splendid and useful crystals will be offered for sale by opticians at as many shillings as real tourmalines cost pounds, and certainly of equal value and practical utility."

8. *Varley's Graphic Telescope.*

Varley's graphic telescope.

Mr. Cornelius Varley, an ingenious optician in Charles Street, Clarendon Square, London, and the author of an admirable treatise "on Optical Drawing Instruments," exhibited in Paris his *graphic telescope*, an instrument with which the most distant views or the nearest objects may be drawn of any size that is required. This instrument may be described as resembling a compound microscope having an

object-glass, a field-glass, and an eye-glass. A plane speculum placed at an angle of 45° to the axis of the instrument reflects the object to be drawn into the object-glass, which would form a image of it in its focus if the rays were not obstructed by the field-glass which contracts the image, and this image is seen distinctly by an eye-glass. The rays from the eye-glass enter the eye parallel but being previously received upon a small plane speculum inclined 45° to the axis of the instrument, the eye receives them after reflexion: and while one portion of the pupil looks into the speculum, and sees the image projected upon a sheet of paper, the rest of the pupil looks past the edge of the speculum, and sees the paper itself upon which the drawer can readily draw with a pencil the picture before him. The size of the image may be varied very considerably without altering the size of the apparatus, so that sketches on a very large or a very small scale may be made by the same instrument. This telescope may be converted into a graphic microscope for drawing the magnified images of objects.

9. *M. Duboscq's Polariscope.*

M. Duboscq's polariscope.

The object of this instrument, constructed and exhibited by M. Duboscq, is to enable philosophers to observe the laws of elliptic polarisation produced by reflexion from the surfaces of bodies as discovered by M. Jamin, and also the laws of reflection and double reflection produced by crystals having a metallic lustre, as investigated by M. Senarmont.

10. *Arago's Interference Refractor.*

Arago's interference refractor.

This instrument, constructed and exhibited by M. Duboscq, is intended to show and to measure the displacement of diffraction fringes, in order to determine inequalities in the refractive power and densities of solid, fluid, and gaseous bodies.

Heliostates and photometers.

M. Duboscq exhibited also the new and improved heliostate of M. Silberman, and the ingenious photometers invented by MM. Babinet and Bernard.

VIII. Instruments for Scientific Instruction.

Instruments for scientific instruction.

Many instruments of great interest were exhibited at the Paris Exposition for assisting the teacher or lecturer in conveying knowledge to his auditors. Several of these were intended for instructing the blind in music and in writing; but the most ingenious and important were those for exhibiting by optical means phenomena and scientific truths to large audiences. Among these stands pre-eminent M. Duboscq's regulator of the electric light.

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1. *Duboscq's Regulator of Electric Light.*

Duboscq's regulator;

The magic lantern was for a long period the only instrument in use for exhibiting phenomena to large audiences. From the faintness of its light, however, and the imperfection both of the optical apparatus employed and the drawings which it projected magnified upon the wall, the effect was very unsatisfactory. The lime-ball light of Mr. Drummond became an excellent substitute for the oil or the gas-lamp of the magic lantern, but the expense of bringing the lime-ball to a white heat with alcohol, and the danger of doing it with a mixture of oxygen and hydrogen gases have prevented it from coming into general use.

The brilliant light produced by placing charcoal between the two poles of a galvanic battery being subject to none of these disadvantages, M. Duboscq has contrived an apparatus by which the electric light produced at the contact of the two charcoal points traversed by the electric current is maintained with a high degree of brilliancy, continuity, and equality of intensity. He has, therefore, been enabled to employ this light either for the ordinary purposes of illumination, or for producing and exhibiting the various phenomena of physical optics, the structure of organic bodies, physical phenomena of all kinds, chemical compositions and decompositions, microscopic objects, and objects of natural history.

its application to various purposes.

In exhibiting with this apparatus very minute microscopic objects, such as the globules of blood of different animals, where a magnifying power of 1,000 or 1,200 diameters is required, the loss of light is so great that the objects themselves would disappear. This difficulty has been surmounted by M. Duboscq in a very ingenious manner. With the electric light, which is highly photogenic, he takes negative pictures of the globules of blood with a power of 300 diameters, which does not extinguish too much of the light that he employs. With these negative pictures he obtains positive ones upon albumenised glass. These positive images are then placed as objects in the tube of a double apparatus, and when illuminated by the electric light, which diverges from the focus of the lenses, they are represented upon the white screen of an enormous size, being magnified 1,000 or 1,200 times.

In order to measure the dimensions of these minute objects thus highly magnified, M. Duboscq places in one of the tubes which receives the divergent light a plate of glass, on the surface of which is a micrometrical scale cut with a fine diamond point. A magnified image of this scale is projected upon the scene, and by a slight motion of the tube which contains it, it is made as distinct as the image which it covers,

in order that the observer may see and measure the dimensions, that is, the diameters of the spherical globules of blood, or the axes of the elliptical ones, so that he not only sees, but has the power of appreciating the magnitude of the different bodies and their parts, which are submitted to his observation.

2. *Nachet's Multocular Microscopes.*

Nachet's multocular microscope

M. Nachet, of whose microscopes we have already spoken in high terms, exhibited various new forms of the instrument, by which their utility has been greatly extended. In order to adapt the microscope for anatomical demonstrations, so that two or three persons may see at the same time the result of microscopical dissections, M. Nachet has constructed two microscopes—a *double* and a *single* one. By means of the first, one person can examine the progress and result of a dissection which is performed by another person; and by means of the second, two persons can enjoy this advantage.

In the microscope for two persons, this result is obtained by placing above the object-glass a prism, the section of which is an equilateral triangle. The rays from the object-glass entering the lower face of the prism perpendicularly, the two halves of the pencil are reflected in opposite directions from the other faces of the prism at angles of 45°, and thus enter the two separate tubes, in each of which they form an image of the object. These images are, in a certain sense, erect, but in order to see them in exactly their natural position, in which case alone the anatomist can use his scalpel, a prism is placed in each tube between the former prism and the eye-pieces, so that their planes of reflection are perpendicular to those of the other prisms. By this means the images are perfectly erect, and the demonstrator can proceed with his work without fatigue or difficulty. If the demonstrator and observer should have eyes of different focal lengths, the adjustment is effected by moving the eye-piece to or from the object-glass.

When the microscope is constructed for three persons, the pencil of rays from the object-glass is divided by three prisms placed in the same plane, and whose, reflecting faces, if brought together, would form a triangular pyramid. The pencil from the object-glass is then divided and directed into three separate tubes, in which three prisms erect the three images, and place them in their natural position.

M. Nachet has also constructed the instrument for the use of *four* persons.

3. *Nachet's Binocular Microscope.*

Nachet's binocular microscope;

The idea of a binocular microscope can hardly be called an invention, if constructed on the same principle as the binocu-

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lar telescope with two object glasses as well as two eye-glasses. The additional expense of such an instrument will not be repaid by any advantage which it is supposed to possess. An instrument of this kind was constructed by Père Cherubin about 1670, but, in so far as we know, no other binocular microscope has been made.

In 1851, Prof. Riddell, of the University of New Orleans, devised and constructed a binocular microscope with the view "of rendering both eyes serviceable in microscopic observations."

Professor Riddell's, of New Orleans.

"Behind the objective," says Professor Riddell, "and as near thereto as practicable, the light is equally divided and bent at right angles, and made to travel in opposite directions by means of two rectangular prisms which are in contact by their edges somewhat ground away; the reflected rays are received at a proper distance for binocular vision upon two other rectangular prisms, and again bent at right angles, being thus either completely inverted for an inverted microscope or restored to their first direction for the direct microscope."

"With these instruments," the author adds, "the microscopic dissecting knife can be exactly guided. In looking at microscopic animal tissues, the single eye may perhaps behold a confused amorphous or nebulous mass, which the pair of eyes instantly shapes into delicate super-imposed membranes with intervening spaces, the thickness of which can be correctly estimated. Blood corpuscles, usually seen as flat discs, loom out as oblate spheroids. In brief, the whole microscopic world as thus diplayed acquires a ten-fold greater interest in every phase, exhibiting in a new light beauty and symmetry indescribable."

Nachet's binocular microscope.

With this instrument, Professor Riddell obtained dissimilar drawings of solid objects by the aid of the camera lucida, and by uniting them in the stereoscope, he brought them out in their natural relief.

When the two tubes of M. Nachet's double microscope are placed vertically and parallel to one another, and are brought so near to the central prism, that their distance is equal to $2\frac{1}{2}$ inches, the distance between the two eyes, the instrument becomes a binocular one, similar to that of Professor Riddell, to whom we must ascribe the merit of the invention, and of that ingenious combination of prisms which constitute the most important part of the multocular microscopes of M. Nachet.

4. *Foucault's Pendulum for showing the Earth's Motion.*

Foucault's pendulum.

M. Foucault's celebrated experiment for showing the motion of the earth was exhibited in a new and highly interesting form in the Palace of Industry. Above the centre of a large

circle divided into 360 parts, there was suspended from the ceiling by a wire 35 ft. long, a ball of soft iron, 5 inches in diameter, terminating below in a point. When the pendulum oscillated, this point passed along a diameter of the circle, at a short distance from its surface, so as to show any change in the plane of oscillation of the pendulum, or in the divided circle. The plane of oscillation of the pendulum being invariable, a fact which we need not here explain, the divided circle, with the building in which it stands, and the observers who are watching it, are all turned round by the earth's daily motion, so that if the index below the iron ball begin its motion along the radius corresponding with zero, it will in thirty-two hours appear to have made the round of the complete circle.

In so far this is the experiment exhibited some years ago by M. Foucault in the cupola of the Pantheon in Paris with a pendulum about 200 ft. long, and repeated in every part of Europe ; but in all those experiments the oscillations of the pendulum continually diminished, and ceased before the index had completed its round. In the present experiment, however, M. Foucault has employed a singularly ingenious contrivance for restoring to the pendulum the force which it loses at every oscillation. This is done by the agency of an electro magnet of a cylindrical form, resting vertically upon a very flexible spring, and reaching nearly to the centre of the divided circle. When the ball of soft iron is at the extremity of its oscillation, the galvanic current is established, and the magnet, now active, attracts the ball in its descent, and restores to it the force which it had lost from the resistance of the air in its previous ascent. But the moment the index reaches the centre with the ball, the electro-magnet is raised with the spring which carries it so as to interrupt the current, and deprive the electro-magnet of its magnetism, and therefore it ceases to act upon the ball during its ascent. In giving an account of this beautiful invention, the Abbé Moigno remarks that the motions of the pendulum are so regular that it will soon be made to indicate the time of the day, and thus become the most extraordinary of clocks.

5. *Ouviere's Uranoscope.*

Ouviere's uranoscope.

This astronomical instrument was exhibited in the garden of the Palace of Industry, and was intended to be, as it were, "a popular observatory," in which every passer by could study the phenomena produced by the daily motion of the earth. In the instrument itself there is no novelty. It is nothing more than a gigantic armillary sphere in which is represented the earth's axis, the plane of the meridian, the celestial equator, the plane of the ecliptic and the zenith

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and nadir of the place. M. Ouviere, of Marseilles, who constructed it, proposes that one should be established in every town in some public and frequented locality. When erected on a lofty pedestal, 20 or 25 feet above the ground, the axis of the instrument is placed parallel to the axis of the earth, and its meridian in the meridian of the place. By looking along the axis the observer below will see the place of the pole star, round which the starry vault seems daily to revolve. By placing himself in the plane of the equator he will trace in the sky the true celestial equator which divides the vault of the heavens into two hemispheres. He will observe the sun at the vernal equinoxes follow that line in his daily movement, approaching gradually to the northern point of the ecliptic as he advances to the summer solstice, returning again to the plane of the equator at the autumnal equinox, and then descending to the lower end of the ecliptic at the winter solstice.

The daily motion of the stars will also be understood from the uranoscope. The observer will trace them from their rising till they pass the meridian of the instrument, and with the aid of his watch he will observe them descending in the same time to the horizon. Day after day they will repeat the same perennial movement, quitting the horizon at the same point, and reaching it where they reached it the day before.

The planets, on the contrary, will, like the sun of their system, pass from their highest northern to their lowest southern declination, varying in their meridian altitude and in their semidiurnal arcs, with a rapidity of change depending on the lengths of their years.

Such is a brief notice of the more important optical instruments, &c., to which my attention was called as Vice-President of the Jury appointed to examine them.

In the great departments of reflecting telescopes and achromatic microscopes, England occupied a place above all other nations. In the department of achromatic telescopes, and in that of philosophical instruments of the highest class, as well as in those for educational purposes, she was far behind France and Germany; and unless the British Government look with more favour upon inventions and inventors, upon science and scientific men, she must be content with occupying the place of a second-rate power in all those phases of civilization which depend upon inventive genius, and the still higher forms of intellectual power.

I have the honour to be, &c.

D. Brewster.

On Warming and Ventilating.—By Dr. Neil Arnott, Member of the International Jury for Class IX.

Dr. Arnott on Warming and Ventilating.

To the Right Hon. the Lord Stanley of Alderley, President of the Board of Trade, &c.

My Lord,

I have the honour in this Report to submit to your Lordship some notes and reflections made during my service as Juror at the late Paris Exhibition.

Among the things necessary to human life, health and comfort, next to food and clothing, must be ranked the means of obtaining for dwellings, in cold climates and seasons, fit warmth, conjoined with sufficient ventilation. Necessaries of life.

The simple means of getting heat, and which has been known from the earliest stages of civilization, is fire, or the burning of some combustible material. Such materials, where cheap, are called fuel; of these wood, peat, and coal are used nearly as nature offers them, and charcoal, coke, and inflammable gas as prepared by art. Kinds of fuel.

But all these combustibles in giving out heat give out also smoke, or burned air containing carbonic acid, which has the properties of defiling and damaging, more or less, whatever it touches, and if retained and concentrated where living beings are breathing, of causing, first, distress, and at last fatal suffocation. The art of warming safely by fire, therefore, includes also that of separating the poison from the warmth; that is, of sufficiently ventilating the places warmed. Poison from burning fuel.

The modes of using fuel with such intention, and the degrees of success attending them, have been and still are very different in different countries. The modes may be classed under the four heads of,— Modes of using fuel.

1. *Open fires.*—These commonly lose all the heat which combines with the smoke, and also much heat diffused in that part of the warmed air of the place which mixes with the smoke as it rises and departs with it to waste.

2. *Close stoves.*—These allow no air to reach the fire or chimney but what is required to support the combustion, and they permit much of the heat of the smoke to remain in the room, after passing through the thin metallic cases or tubular chimnies. They generally warm a room as much with one portion of fuel as a common open fire does with four portions.

Dr. Arnott on Warming and Ventilating.

3. Circulation of hot water in pipes or other vessels, heated from a furnace, having nearly the economical qualities of the close stove.

4. Diffusion of heat from metallic pipes or vessels, which receive steam from a boiler with an enclosed furnace.

These four modes are here to be considered in succession.

I.—Open Fires.

Open fires.

The open fire, although, as above stated, it is more wasteful than the close stove, and has other disadvantages yet to be spoken of, still has properties which cause it to be generally preferred wherever fuel is cheap. It is so simple that any person can learn to light and feed it; it is pleasing to the sight, and it is felt by many to be in winter a cheerful companion. The great faults of open fires of the common type are,—

1. Smoke.
2. Waste of fuel.
3. Unequal heating of the rooms.
4. Trouble of management and watching.

Effects in London.

In London alone, for instance, examination has ascertained that on account of the smoky atmosphere the inhabitants have to pay for washing their clothes two millions and a half sterling per year more than if they lived in the country; that they now consume at least another million's worth of coal more than even with good open fires would be needed; that a considerable part of the winter diseases and premature mortality of the city is due to faults in respect to temperature and ventilation; and that the number of domestic servants is much greater because of their having to manage the present open fires.

Evils but lately understood.

It is but lately that these evils connected with common open fires have been fairly looked at and acknowledged by scientific men, and particularly by architects, whose business it was to avoid and correct the errors. Architects have been earnest in devising beautiful forms, but have deemed the chemistry and mechanics of the fireplace and chimney not worth their notice. The construction and management of grates were left, therefore, almost entirely to the care and misconceptions of little-educated workmen and servants. It is true that Mr. Gauger and others in France, Dr. Franklin and others in America, and Count Rumford and others in England, made important remarks, and gave very useful counsel respecting fires, and that the latter particularly improved not a little common practice by explaining the advantages of narrowing the chimney throats; but many lessons are required to change

established practice founded on popular ignorance. Rumford showed that of the heat produced in the common fires of his day about seven-eighths went up the chimney to waste.

DR. ARNOTT ON WARMING AND VENTILATING.

In 1838 Dr. Neil Arnott, of London, the writer of this article, having, during the exercise of his profession, remarked that a large proportion of the diseases occurring were caused by errors of management in regard to heat and air, published a little work on warming and ventilating, in which many common errors were pointed out, and some modes of remedying faults were described. But being then fully occupied in practice, he could do little more than advise; and because he had not reserved any patent interest in his suggestions, many, doubting whether they were of practical value, waited for proofs. The book, however, awakened the minds of stove manufacturers to the importance of the subject, and patents without number, as again at present, were taken for supposed improvements. These evinced, however, rather the former prepossessions than the correct knowledge of the parties.

Dr. Arnott's Treatises.

Dr. A. has lately published a second treatise on the same subjects, entitled "On the Smokeless Fire, and other Means, "Old and New, of Warming and Ventilating." It contains the substance of the former treatise, with additions. For the novelties deemed of importance, the Council of the Royal Society of London, in 1854, awarded him their Rumford Medal, and for the same and some other means, as the water-bed, of a remedial or sanitary nature, of which London manufacturers had sent specimens to the Paris Exhibition of 1855, the Council of Presidents of the International Juries awarded him the Grande Médaille d'Or, for the Class XII., "of Hygiene, Surgery, and Medicine," and the Emperor added the Croix de la Légion d'Honneur.

Novelties.

The principal novelties are,—

1. The smokeless open fire.
2. Self-regulating and self-feeding close stove.
3. The same, with modifications, for warming spacious buildings by hot water or steam.
4. Ventilating pump for large edifices.
5. The heat-transferrer, by which hot foul air passing away is made to warm pure air entering.

Commission of inquiry.

The President of the General Board of Health in London has now deemed it right to name a commission to examine and report on the performance of some of the objects above mentioned, which are already in use. This has been done to test again the merits; and, if merit be found, to lessen obstacles always existing to the introduction of novelties

Dr. Arnott on Warming and Ventilating.

and especially if no individual has pecuniary interest to labour for their adoption.

In the new *smokeless fire* are combined various particulars which intelligent men at former times had thought of and used singly, but of which, when used singly and imperfectly, the value was so small that they have not been duly appreciated.

Narrow chimney throat.

1. Such was the narrowing of the throat of the chimney proposed by Count Rumford, which, when effected in the exact degree required, allows only what may be called the *true smoke* to pass away, and not also four or many more times as much of the pure warm air from the room accompanying the smoke to waste, as happens in common wide-throated flues; but, for want of a throttle valve or other register in the flue, with an index always clearly seen, which might be adjusted carefully, after lighting the fire, to the force of the chimney draught as influenced by the wind and other causes, the brick-contracted throat of Rumford was found generally to be either too much or too little contracted, and the true value of the contrivance was not understood.

Fuel supplied from beneath.

2. Such, again, was the plan of Mr. Cutler and others, of placing the charge for the day of fresh coal in a box underneath the fire, so that when coal was wanted, it could be raised up into the grate by mechanical force, ensuring that all the smoke issuing from it should pass through the ignited coal to be burned. But because of the complexity of the raising mechanism used, and the want of a proper throttle-valve or damper for the chimney, as above described, with contraction of the space over the fire (yet to be explained), to give strong draught and perfect command of the combustion, that plan, although strongly pressed on public notice, was soon abandoned.

Blower and narrowed space.

3. Then, again, many persons saw how strikingly the activity of the combustion of a common fire is under command where there is a blower or apron to the grate, or where the space between the fuel and the chimney throat is lessened by a lining of fire-brick, producing nearly the same effect as a blower; but not sufficiently aware that excessive action of these is completely preventible by the chimney throttle valve, and believing erroneously that the hot smoke, while rising through a large open space over the fire, radiates much heat into the room, they did not contract that space nor use the blower, and so missed both the required control over the combustion, and allowed the true smoke to mix with and drag along with it a large quantity of the pure warm air about the fire.

4. Then, intelligent persons had noted the extraordinary powers of ventilating the room obtained by an opening made near the ceiling where the hot foul air is usually collected, into the flue of a strongly drawing chimney; but from not knowing that, by narrowing the space over the fire and the throat of the chimney, only very hot air is allowed to enter the flue,—and not reflecting that the chimney draught is strong in proportion to that heat,—and not aware that a balanced valve of metal placed in the ventilating opening would allow the foul air from the room to enter, but no smoke to escape,—such arrangement has been rarely adopted.

Ventilation by chimney flue.

5. Then, lastly, persons have made channels for fresh air to enter the rooms, and spread from near the fire-place, but because the inner openings were either under the grate, so that the air blew the fire irregularly, and scattered the ash dust, or because the air was admitted to channels too close to the grate, in which it was overheated, and then ascended away to the ceiling, like a fire-balloon, doing little service below, the plan got little favour. By allowing the fresh air, however, to enter under a broad clean fender, it is gently warmed by contact with that, and then spreads insensibly in the room, pure and tempered, preventing quite the cold draughts from windows or doors, so much complained of in ordinary cases.

Admission of fresh air.

In the new smokeless open fire, these five objects are combined in fit manner and degrees, and other important objects, as the high or low position of the fire, are attended to. The chief results may be enumerated thus:—

Qualities of the new smokeless fire.

1. The fire is smokeless.
2. It consumes one third less coal than a common grate does to warm the room to the same degree.
3. It so much increases the chimney draught as to cure any smoky or ill-drawing chimney, and it perfectly ventilates the room, through the valve, at any desired rate.
4. It diffuses the heat generated much more equably than common fires.
5. It will remain alight, when fitly arranged, without being touched, for twelve hours and more.
6. It saves chimney sweeping, for it makes little or no soot.
7. It diminishes remarkably the trouble of attendance.

Charbon de Paris.

A very important object exhibited in the Paris Exhibition was a prepared fuel, called the "charbon de Paris." The manufacturer takes fragments or dust of bituminous coal, or of anthracite, charcoal, or coke, and mixing these in

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certain proportions with coal-tar, he makes a soft mass, which, by moulds, he shapes into cylindrical pieces of about 4 inches long and $1\frac{1}{4}$ in diameter, and he afterwards hardens them by heat. These burn very like charcoal, free from smoke, and giving intense heat. There are now many makers of such fuel, seeming to believe the excellence of their product to depend chiefly on the proportions of the ingredients, and attributing too little to the uniform size and shape of the pieces, which allow that rightly proportioned approach of air to them on which perfect combustion so much depends.

Other artificial fuel.

There were in the Exhibition many specimens, both Continental and English, of artificial coal or fuel of kindred composition, in much larger masses. An obvious advantage of such over common coal is that the lumps, when put together, occupy less space than an equal weight of irregularly broken common coal, and therefore can be stored more advantageously in ships. And in the composition there may be of bitumen or pitchy matter just what aids the steady combustion without causing smoke, having, therefore, neither the excess nor the deficiency found in many natural coals.

Gas fuel.

The use of *coal gas* as a fuel for cooking, and sometimes for warming rooms, is spreading over Europe, and well suited apparatus had been sent to the Exhibition from several countries. For the purpose of warming a room gas is a very expensive fuel, but for cooking it may, in many cases, be both convenient and economical. Evident advantages are, that the fire has not to be lighted until the moment when the cooking begins, that it can easily, by the regulating cock, be rendered and maintained of exactly the requisite strength, and that it can be extinguished at once when the work is done.

Open fire-grates.

In the Paris Exhibition there were open fire-grates, of variety almost endless, fitted for burning wood or coal. Many were very tasteful, and of perfect workmanship, but exhibiting no important novelty of principle. There were very ornamental and costly grates from England, as might be expected, from the open grate being there the universal fireplace, owing to the abundance and cheapness of the bituminous coal fitted for them. Several of the London manufacturers had sent specimens of the new smokeless grate.

Smoke in London and Paris.

Until recently the kinds of fuel burned in Paris were chiefly wood and charcoal, which, from their nature, produce very little smoke. Hence the remarkable clearness of the sky in Paris, and the unsoiled exterior and interior of the buildings, compared with the smoke-loaded atmosphere and the

blackened walls of London, where bituminous coal almost alone is employed. Now, however, the use of bituminous coal is rapidly extending in Paris, and, unless precautions be taken, the same consequences will follow as in London. There is no good reason why the legislatures in both cities should not interfere with respect to the smoke of domestic fires, as has already been done in London so usefully with respect to that of the furnaces of steam engines and others. Thus all the evils from smoke, as set forth at the beginning of this Report, would be much abated in London, and would never exist in Paris.

II.—Of the Close Stove.

Close stove.

This has been made hitherto nearly in the same ways in all countries. It encloses the fires, so that no air can enter it, or can pass by the chimney, except what is wanted to support the combustion; and much of the heat of the smoke passing through the metallic or brick material of the construction remains in the room, as already mentioned. One portion of coal burned in such a stove warms a room as much as about four times the quantity burned in an open fire. Little smoke is produced in it.

Close stoves are very common in Paris, and are of great variety of form. They differ from English specimens, in having generally greater extent of exposed metallic chimney-tubes for giving out heat, arranged in tasteful ways.

Stoves which burn uninterruptedly.

Among the close stoves sent to the Paris Exhibition by English makers, were some for burning non-bituminous fuel, as coke, anthracite, or charcoal, showing the modifications devised by Dr. Arnott for obtaining important new qualities in that form of fireplace. The balanced-valve regulator gives complete control over the entering air, causing the combustion to be as uniform as is that of a candle, and by a simple adjustment of it, the consumption of fuel may be increased or diminished at will, by a single pound in 24 hours. A receptacle to contain fuel enough for 24 or even 48 hours is placed with its open mouth immediately over the fire, and fresh fuel falls from above as the fuel below is consumed. The fire burns thus during a whole winter without being extinguished, and requires little more service than a kitchen clock. Such a stove as now described has performed in the dining-room of the writer for sixteen years, and during that time there has not been need to sweep the chimney.

Self-regulation of combustion

The regulator of this stove is minutely described in the published treatise. It is of great simplicity, and costs only a

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few shillings. It is not easily hurt or deranged. Many forms of such regulator were devised by the inventor, when years ago he formed arrangements for maintaining an absolutely uniform temperature in chemical and other apparatus. Mons. M. E. Rolland, of Paris, has lately devised kindred forms of thermostat for his apparatus, called Torrefacteur, exhibited in Class IX. of the Paris Exposition, without being aware that such arrangements had been made before.

III., IV.—Self-regulating Fire for heating Water and for producing Steam.

in furnaces.

The stove above described may have its walls double, with water between them, and thus will maintain hot any desired quantity of water for the use of bedrooms, nurseries, &c.; and a larger fire or furnace so regulated may be used to heat boilers for the warming of large buildings, by circulation of water, or to produce steam for the same purpose.

Ventilation.

Ventilation.

Ventilation of a single room in summer may be effected by windows open at the top. In winter it is supposed in general to be sufficiently secured by the stream of air passing up the chimney from the fireplace, and it may then be rendered perfect by a ventilating valve, properly managed. But where a spacious building is to be ventilated by night and by day, in summer and in winter, as a hospital or barrack, other means are required. Those, now for some years employed, are chiefly of two kinds.

Heated shaft.

1. A lofty shaft or chimney, heated by a fire or hot water pipes, and having communication with the places to be purified. In France such a shaft is called *cheminée d'appel.*

Air pumps, &c.

2. Air pumps or fan wheels, driven by machinery, which may be used either to force air into the building through fit channels, or to draw air out, like the heated shaft; and by whichever of these means the vitiated air from the rooms is caused to leave them, it may issue either through openings near the ceilings, producing upward ventilation, or through openings near the floors, effecting downward ventilation.

Downward ventilation;

In many English prisons ventilated by a hot shaft, the pure air, warmed or cool, is caused to enter the cells near the top, and the impure air is withdrawn through openings near the bottom. This system has not given great satisfaction. With some desirable qualities, it has one which is decidedly bad. A good qualitiy is, that it diffuses in a room the

warmth of entering air more equably than when the source of heat is below; for warm air entering being lighter than the mass in the room, spreads itself all over that, and descends only as it cools and as more fresh warm air enters. The system is economical also, for the air which is passing away at the bottom, being the heaviest air in the room, is also the coldest, and therefore in departing carries away little heat. The heaviest air, however, is not the most impure air, as that should be which is departing, for the impure breath being warm always rises to mix with the entering fresh air, and so remains to be in part breathed again.

In France.

In France, for many hospitals, prisons, and large halls of assembly, this mode of descending ventilation, by departing currents at the floor drawn towards a heated shaft is adopted. In some the pure air enters below already heated, and in some it is heated in the room by contact with surfaces of what are called water stoves, containing circulating hot water. It is impossible after a little time that any person in such places can be breathing air perfectly pure, for unless the whole mass of air in the room be forced downwards to escape at the floor with greater speed than the hot breath is rising through the general mass, the breath must ascend and be diffused in the mass, and must soon descend again, although diluted, to enter more or less the chests of all persons present.

House of Commons.

In the old English House of Commons pure air, drawn from a high tower, and moderately warmed, was admitted through many apertures in the floor, and the impure foul air was drawn away through openings above to a lofty heated ventilating shaft. This plan, while under the direction of Dr. Reid, was found for years to answer very well.

House of Lords.

In the English House of Lords steam-engines of 20-horse power are used to impel air along channels among pipes heated by containing steam, and then into the great hall of the members. The impure air is by the entering pure air forced out of the chamber, chiefly through openings at the top towards a ventilating shaft or chimney. This system to act well requires constant skilled attendance, and in its first establishment is very costly.

Paris.

The plans adopted in Paris for warming and ventilating certain large buildings by Messrs. Leon Duvoir Le Blanc, René Duvoir, Grouvelle, Thomas et Laurent, and others, in explanation of which there were models and drawings in the Exposition, are also examples of the systems above described. In those in which the heated shaft is used there is only the feeble and unsteady chimney force, which is too liable to failure.

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M. Leon Duvoir.

Mr. Leon Duvoir Le Blanc heats all the rooms of a building by circulation of hot water from a single boiler placed in the basement. The water is forced up from that to a high reservoir by the weight of the descending currents, from which reservoir tubes pass to every room, carrying the hot water to vessels there called water stoves (poêles d'eau), from which, when cooled, it descends to be re-heated. The body of a water-stove is pierced by many passages or tubes open at both ends, through which passages the fresh air is caused to enter the room, and when warmed by the contact rises towards the ceiling. The heaviest, because coldest air of the room subsides to near the floor, and there, in proportion as fresh air enters, passes away by the ventilating openings. This system has the advantages of saving fuel as above described, and of causing uniform distribution of warmth, but it has the disadvantages of the impurity left, owing to the low exit of the air, and of the feeble and unsteady propelling power.

M. René Duvoir.

In the plan of M. René Duvoir, established at l'Ecole Polytechnique and elsewhere, hot water circulates from the boiler in larger tubes placed in channels formed in the walls and floors, along which also the fresh air moves towards the rooms. In other respects there is much resemblance to the plan of M. Duvoir Le Blanc. It is some advantage that there cannot be warming of the rooms without ventilation, because warmth can be carried in only by the fresh air. Then the air in rising through warm channels becomes warm columns, aiding the action of the cheminée d'appel or shaft.

M. Grouvelle.

M. Grouvelle's system has also the shaft and central boiler with water stoves, but the water in the stoves is heated not always directly in the boiler, but by steam rising from the boiler to the stoves, or to distinct partial water circulations. There are cocks as in all the other arrangements spoken of for regulating the distribution of heat according to the need.

Thomas and Laurent.

Messrs. Thomas and Laurent, as exhibited at the hospital Lariboisière, use steam engines of 20-horse power to force the air by fan-wheels through the building. The fresh air is heated by the steam of the engines after that has done its work in them. The injection of the fresh air drives the used air out of the wards by openings chiefly in the side walls, some of them being halfway up, some lower down. The expense of the first establishment of such apparatus is very great.

Desideratum.

The evident desideratum, then, for the effectual ventilation of large buildings is a simple, and therefore, cheap mechanical

power, which can either force or draw air as desired, and which shall work with unfailing regularity according to requisite and clearly defined measure. It should take the place of the expensive and unsightly shafts, and of the steam engines above described, or of steam-jets,—working uniformly through the nights as well as the days, and avoiding the necessity for fires, and for the watching of skilled attendants.

Such an air-moving apparatus, it is believed, exists in the ventilating pump devised by Dr. Arnott, of the body of which there was a model in the Paris Exhibition. The convenient mode of working one, however large, is not by a steam engine, but by the ordinary supply of water to the house, delivered at first into a cistern placed high in the house, and made to move the pump as it gradually descends to lower levels for the domestic uses. By an easy arrangement every pint of water which descends 20 yards is caused to force 240 cubic feet of pure air into the house, through branching channels of distribution if desired, and the pump works by night as by day with the regularity of a clock, and stops only if the daily supply of water from the water company should fail.

New ventilating pump.

The following extract from a Minute of the General Board of Health, dated October 4, 1850, relates to a trial of the apparatus made, while one intended for the new hospital at York was yet in the manufactory of the contractors, Messrs. Bailey, 272, Holborn, London.

"The Board, accompanied by Mr. Austen, Dr. Sutherland, Mr. Rammell, having inspected the new engine and apparatus for the ventilation of the York Hospital, and having consulted their officers, were of opinion that the machine and arrangements were of a highly important character, as going far to solve the question of cheap and efficient ventilation. In this case the cost of the ventilation of a building to accommodate 1,000 persons would probably not exceed one shilling per day. Considering the importance, in a sanitary point of view, of an apparatus capable at so small a cost of regulating day and night, without superintendence, the quantity of air drawn in and out of dwelling and sleeping rooms, the Board deems it desirable to communicate with the directors of the York hospital, and to obtain from them the results of its practical working."

Minute of the Board of Health.

After the apparatus had been in use at York for two years, the committee of management of the hospital reported to the Board of Health that the performance "was highly satisfactory."

Hospital at York.

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Heat transferrer.

Of the heat-transferrer mentioned in the beginning of this Report as one of the new things devised by Dr. Arnott, by which hot foul air in passing away from any enclosed place is caused to give its heat to fresh air entering, no model was placed in the Exhibition, but the subject was brought forward, at a meeting of the Institute of France by a distinguished member, on his presenting to the Library a copy of the Treatise on the smokeless fire, &c., and it excited a lively interest.

It is hoped that the Commission named by the President of the Board of Health to examine some of the new devices referred to above will soon have to make a Report.

I have, &c.

N. Arnott.

On Naval Constructions.—By Francis Fowke, Captain Royal Engineers.

To the Right Hon. the Lord Stanley of Alderley,
President of the Board of Trade, &c.

My Lord,

The Sections of the XIIIth Class, in which are contained the objects connected with Naval Art, are numbered and designated as follows:—

Section I.—*Principal Elements of Naval Constructive Materials; and of the Art of Navigation.* French classification.

Designs and models of the fittings of workshops, building yards, building slips, &c.
Tools used in ship-building; apparatus of all kinds for the preparation of the raw material
Wrought timber of all kinds, metals, tar, oakum, &c.
Cordage of all kinds.
Rigging and sails.
Masts and yards of all kinds of a single piece, and built.
Anchors, pullies, capstans, pumps, and other special apparatus.
Detached pieces of steamers, such as paddles, screws, &c.
Special fittings for ships, such as hammocks, kitchen utensils of all sorts.
Illustrations of processes for sheathing and caulking at sea.
Flags and signals.
Things appertaining to the art of navigation, instruments, charts, &c. (except where treated of in Class VIII.)

Section II.—*Apparatus for Swimming, Safety, Exploring, &c.*

Swimming apparatus.
Safety-boats and apparatus.
Insubmersible boats of all kinds.
Diving bells and submarine apparatus (except when in Class XIV.)

Section III.—*Designs and Models of the various Systems of Construction of Vessels employed on Rivers, Canals, and Lakes.*

Floating trains and other special constructions, rafts, &c.
Skiffs, canoes, and row-boats generally.
Boats of transport on rivers and canals for travellers and merchandise.
Systems of towing.
Steamers.

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Section IV.—*Designs and Models of Systems of Naval Construction in Vessels employed in Commerce and Sea Fishing.*

Sea-going vessels or boats with oars.
Sailing vessels of all sizes for passengers or merchandise.
Steamers for passengers or freight, tugs.
Vessels with auxiliary steam power.
Steamers for both river and steam navigation.
Sea-going yachts.
Fishing boats with their fittings.

Section V.—*Designs and Models of Systems of Construction in Vessels employed for Warlike Purposes.*

Sailing vessels of all ranks and kinds.
Steamers, both paddle and screw, of all ranks and kinds.
Gun-boats, blockships, fireships, submarine boats, &c.
Apparatus of various kinds, used specially in navies.
Kitchens, distilling apparatus, &c.

This section completes the list of articles relating to naval matters; the remaining sections of this class being devoted to the enumeration of military objects, which part of the subject has already been dealt with in the first volume of these reports.

Of the numerous objects comprehended under the various heads just mentioned, a great part can only be lightly touched upon in speaking of nautical affairs, as many of them belong to this class only in special instances, and have been dealt with in their more general character by the juries of the various classes to which they individually belong; such objects can, therefore, only enter into the present report in their bearing upon naval art and architecture, and without reference to their abstract and individual merits. Under this head may be classed many of the tools and materials mentioned in the opening classes, the philosophical instruments and chests, also marine steam-engines and machinery of every kind, now become so important a branch of nautical matters, which are, of course, more properly contained in Class IV., but which it will be necessary to notice in following out the objects of this report, one of which is to consider how far the representation of this branch of industry in the Paris Exhibition may be taken as an evidence of the progress of the several nations since the period of the Great Exhibition of 1851, and to trace, as far as is conformable to the limits of so short a paper, in what direction that progress has been principally developed.

In the opening subdivisions of Section I., the French Minister de la Marine exhibits a collection of apparatus and machines in use in the naval establishments of France, some of which are novel and interesting, such as a small machine for making trenails, in which they are pressed through a sort of die, and submitted to a considerable pressure after having been cut into shape; a machine for twisting or rather braiding signal haulyards which does the same work as that in use at the dockyard at Plymouth, but in a totally different manner, having a motion more automatic and less machine-like, the bobbins being moved over each other in much the same manner as if done by hand. Two large models, also forming part of the contribution of the Minister de la Marine, are for the purpose of illustrating and explaining the mode recently adopted for launching the line of battle ship Ulm, the river Charente, on the bank of which she was constructed, not being of sufficient width to admit of her being launched in the ordinary manner, M. Sabatier, the naval engineer, devised a method in which, by attaching cables which should break in succession on receiving the full strain, the vessel would be turned sufficiently quickly to enable her to be brought up without touching the opposite bank, and which is said to have answered perfectly.

Dockyard machinery.

Models of launching the "Ulm."

A trenail cutting-machine is exhibited in the Canadian department, which, although of an inexpensive construction like all their wood-working machinery, is remarkable simple, and seems calculated to do its work well; it also applies pressure to the trenail as well as merely cutting it.

Canadian trenail machine.

An American, a Mr. Blanchard, who is also the inventor of a self-acting lathe for turning irregular forms, has a very remarkable apparatus for bending ships' knees, and breast hooks and timbers of all sizes from straight timber, and thus avoiding the necessity of searching for natural knees and hooks where wood is employed for these purposes. The inventor goes on the principle that when a piece of wood is bent by ordinary means the grain or fibre on the inside of the curve remains pretty nearly in its normal state, thus obliging the fibre on the outer part of the curve to stretch or elongate, until, if the operation be continued, its powers of cohesion are overcome, and a fracture beginning at the outside or extrados of the curve is the consequence; from this he argues that if the wood be bent without allowing the outer part of the curve to lengthen it can be made to take any curve however sharp or angular, and this he effects by compressing the wood in the direction of its length while

Blanchard's wood bending.

Capt. Fowke on Naval Constructions.

it is undergoing the operation of bending, by which means the inner part of the fibre becomes compressed and shortened, while the outer remains of its original length. Several specimens of bent timber accompany the working model of the apparatus, one of which is a ship's knee fourteen inches square bent nearly to a right angle; the timber, it should be remarked, is submitted to the action of steam in the ordinary manner before being put into the machine.

Normand's saw-mills.

A saw worked by steam power, invented by M. Normand, a shipbuilder, of Havre, seems a valuable adjunct to a naval workshop, and a decided improvement on the saw-mill at present in use. It is for the purpose of cutting timbers, not only of any curve, but also such as have a curvature in two planes, or are what is technically termed in winding; it will also saw two sides of a timber at once, and which can be made parallel, converging or diverging at pleasure; this part of the apparatus can also be made self-acting, so as to increase or decrease a timber in a given regular proportion from end to end. The machine consists of two reciprocating saws set in the same frame and working perpendicularly, only differing from the common up and down saw of a saw mill in being moveable on a vertical pivot at top and bottom, so that either or both are capable of being diverted in a very slight degree from their original position to the right or left. The timber to be cut is placed on four transverse horizontal rollers, moveable at will in the same plane in such a manner as that the lines of their axes, instead of remaining parallel, shall on being produced always meet in one point, this point being on one side or other of the machine, and approaching it or retiring as the rollers recede from or return to their original position, viz., that of being parallel to each other and at right angles to the cut of the saw. The baulk to be cut being carried forward on these rollers, and receiving its direction from them, will move in an arc of a circle, of which the point of meeting of their axes produced in the centre, and as the workman in charge of the machine holds a sort of tiller by which he can change the length of radius at pleasure, he has the power of making the piece of timber follow any curve, and in fact is enabled to steer it through the machine. The power of making a cut in torsion is obtained by having the entire framework supporting the rollers moveable on a longitudinal horizontal axis, and a simple arrangement with a ratchet wheel makes this motion regularly continuous and self-acting. In the motion first described, the imaginary centre of the arc in which the timber travels being

always abreast of the saw obviates the necessity of altering the latter from its position, as it is always cutting at right angles to a radius which in direction is common to every arc which the baulk can be made to describe; in the case of the two saws being made to gradually approach or retire from each other, so as to give converging or diverging cuts, a slight cant inwards or outwards, as the case may be, is given them to facilitate their working. The inventor of this machine has also a reciprocating saw for straight work, the motion of which, instead of being straight up and down as in a saw mill, is made to resemble that of a saw worked by manual labour in a pit; the advantage is said to be that whereas in an ordinary saw mill, where the teeth follow in exactly the same course, a great deal of the power is expended in merely pulverizing the sawdust, in this saw on the contrary, from the saw traversing an arc instead of a straight line, each tooth cuts at a different part of the wood; the saw is also made to retire on the up-stroke, which is a further economy of power.

Normand's saw mills.

Among the novelties in what may be called dockyard machinery is a sewing machine adapted for sailmaking, to which purpose it has been applied in America, the entire suit of sails for the great sailing ship, the Great Republic, having been made by machinery in ten days.

Machine for sewing sails.

There are many exhibitors of cordage, but as no trials were made of the strength of the different ropes and other cordage, they can merely be judged of from the evenness and finish which they displayed, without reference to their qualities of endurance. The French Minister of Marine exposes a hawser for a vessel of the first class, and other cordage. One of the most important exhibitors of this manufacture is the house of Merlie, Lefevre, and Co., of Havre, to whom the world is indebted for many useful machines in their particular trade. All their cordage is made by machinery, and their establishment is capable of turning out 3,800 to 4,000 lbs. weight of ropeyarns a-day, and during the past year, independently of their commercial sales of upwards of 600 tons, furnished the French Government with 500 tons for the use of the navy. One of the ropes in the Exhibition of this firm is made in a peculiar manner, the strands being formed of ropeyarn, and each covered with three-thread twine; it appearing that on opening a rope that has been used the yarns on the exterior of the strands are found to have borne the principal part of the strain, while those in the interior are comparatively untouched. Messrs. Merlie have conceived the idea of forming the exterior envelope of

Exhibitors of cordage.

Minister of Marine.

Merlie and Co.

Capt. Fowke on Naval Constructions.

each strand of three-thread twine, which, being possessed of greater elasticity than the ordinary ropeyarn, stretches to a certain extent, and allows the latter to bear its proper proportion of strain; and it is said that this theory has been borne out by actual trial. Another advantage in this rope is said to be that the twine being harder, acts as a kind of serving, and prevents the rope being chafed.

Flachon's rope of wire and hemp.

M. Flachon, of Condrieu, manufactures a peculiar kind of rope, which consists of iron wire covered with hemp, the advantages of which, however, appear doubtful, as it is heavier than ordinary rope, and from its want of flexibility does not seem at all adapted for marine purposes; besides which, the strain on the wire and hemp must necessarily be unequal, particularly when employed in situations where they are subject to various degrees of moisture, and the deterioration of the latter from chafing would probably be very great.

The Exhibition was rich in small contrivances of many sorts connected with shipping; and, perhaps, no one subject in this class had so many varieties as that of logs and sounding machines of different kinds. And first may be placed a little apparatus that claims to be capable of acting in both of these capacities, viz., the log-sounder of Captain Pecoul, of Marseilles.

Captain Pecoul's sounding log.

It consists of a hollow pyramid of copper, having an equilateral triangle for its base, and three convex isoscele triangles for sides; this forms a small buoy capable of supporting a weight of 6 lbs. At the apex of the pyramid is fixed a small pulley, through which the log-line passes, having the lead attached to its end; a circular spring on the pulley permits the line to run out as long as it is drawn by the weight of the lead, and stops it on the latter touching the bottom, the buoy then lying down on one side. The advantage of this instrument is, that soundings can be taken without heaving to or stopping the ship's way, as on the buoy and lead being thrown overboard, the former remains stationary on the water, and the latter runs out the line through the pulley till it comes in contact with the bottom, when it is stopped by the spring above mentioned, and on being hauled on board, the mark on the lead line shows the soundings in fathoms; in the operation of hauling on board the buoy coming in horizontally, the line forms a very acute angle at the spring, thus rendering it impossible for the line to slip. The instrument can also be used as a log for measuring the distance run; in this case the lead is stopped from going to the bottom by inserting a small toggle between the strands of the line,

and a cork attached to the line at about 2 feet 6 inches from the pulley holds the pin or faucet, which is connected with the two other angles of one of the sides of the buoy by small pieces of line in the same way as in the ordinary log, and the operation of heaving in also exactly the same. CAPT. FOWKE ON NAVAL CONSTRUCTIONS.

M. Lecoentre exhibits a sounding lead in which a small screw is turned by the passage of the lead through the water, and the depth registered on a dial attached. Lecoentre's lead.

M. Montrignier Monnet has a log on something of the principle of Massey's patent log, in which each revolution of a small copper screw indicates an advance of one metre; it is attached to the end of a long rod, and on being plunged into the water, the other end being held in the hand, a slight motion is communicated through the rod at each revolution of the screw, thus enabling the observer to count the number of metres run in a minute or any other given time, and consequently to calculate the speed of the ships. Monnet's log.

An instrument invented by M. Dromet, and to which he has given the name of velocimetre, is also for the purpose of measuring the speed of vessels. It consists of a tube a foot or eighteen inches in length, composed of two truncated cones united at their smaller ends; at the intersection of the cones a small tube rises, in which is produced an exhaustion, which increases as the speed of the ship, and this acting on a vacuum guage records on a dial the velocity acquired. This apparatus is said to succeed well on board several vessels and yachts in which it is fitted. Dromet's velocimetre.

A curious little diving bell is shown among the French nautical instruments; instead of being constructed like the ordinary bell to accommodate one or more men, it is merely large enough to contain the head of a man, who is thus supplied with air while working under water, a seat being slung from it on which the workman sits. The object of the inventor is to provide ships with a simple and cheap apparatus, by which a man can be sent down at any time to examine the bottom while at sea, and even to execute trifling repairs. The mode of supplying the diver with air is ingenious, and curious from its very simplicity; instead of pumping air through a hose, as in the more finished and perfect apparatus, it is sent down by another little bell, or even a bucket reversed, which the diver empties as it were into his headpiece. Small diving bells.

There is a good representation of the diving apparatus, now so well known under the name of diving dress. England sends three, exhibited by Messrs. Tylor, Heinke, and Diving dresses.

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Siebé; two, viz., those of M. Cabriol and M. Ernoux, are French, and one is among the india-rubber goods contributed by the United States. Between these it is extremely difficult to discover any important difference, and the only advantages claimed by the various proprietors are either goodness of workmanship, lowness of price, or improvements in detail, the main principles of all being precisely alike.

Heinke's apparatus.

Mr. Heinke's apparatus differs from the others in having a valve, by means of which the diver is able to cause the air to pass from his helmet into the india-rubber part of the dress, and by inflating it is thus given the power of rising at pleasure to the surface, without waiting to be hauled up. In this apparatus the diver is also able to shut the valve by which the vitiated air escapes, and in the case of a glass being accidentally broken, or in fact of any leak taking place, a considerable rush of air can thus be forced through the aperture, and the water by this means prevented from entering. This has already been the means of saving more than one life. In all the English dresses a small quantity of air is enclosed in the india-rubber part of the dress for the purpose of relieving the limbs of the diver from the pressure of the water when working at great depths, but in the dresses exhibited by the French makers this does not appear to be the case, the principal study of the manufacturers of which seems to have been rather to produce their apparatus at as low a price as possible than to introduce

American apparatus.

any improvements. Of the American dress no opinion can be given, as no description was sent along with it, and it was not brought forward at the trials which were made of the different apparatus. In one of the French dresses a pressure gauge is attached to the air-pump for the purpose of indicating the pressure of air on the diver, and consequently the depth to which he has attained. In case of any accident happening to the pipe that supplies him with air this would probably give timely warning, and in that case must be looked upon as a valuable addition. The same

Cabriol's apparatus.

maker, M. Cabriol, also provides the helmet with a small cock opposite the mouth, so that the diver can be supplied with atmospheric air directly on emerging from the water, which might be useful in cases of his being seized with sudden illness or fits of any kind.

Ernoux's apparatus.

In the apparatus of M. Ernoux no air-pump is necessary, as the diver is supplied with air by means of an ordinary ship's fire-engine, which of course makes a considerable reduction in the cost of the apparatus.

Payerne's submarine boat.

Among the diving apparatus may be noticed a submarine

boat invented by Dr. Payerne. A sectional model of it is exhibited among the French naval models, which shows the internal arrangements. It differs from the diving or submarine boat formerly constructed by the same person, in being propelled by a screw moved by a steam-engine, the fuel being mixed with some substance, such as nitrate of potassium or nitrate of soda, so as to be rendered independent of the atmosphere for its supply of oxygen, and the furnace being entirely isolated from the rest of the vessel. The idea is ingenious, and the construction appears simple, but as it is not stated that any actual experiments have been made, it is difficult to pronounce upon the merits of the apparatus. Dr. Payerne is the inventor of a submarine boat that is now used with success at Cherbourg. It was at first constructed with a length of 30 feet, for four workmen, and was used at Brest, in 1847, in removing a hard rock in front of one of the building slips at a depth of 40 feet below the surface. In 1849 the same boat was employed in the Seine in the destruction of the old "Pont au Diable," at Paris. In 1853, being in use at Cherbourg, it was cut in two, and increased to 49 feet in length, so as to enable it to hold twelve more workmen, and it is now constantly at work at that place, the amount of labour performed being the removal, on an average, of 40 cubic feet of granite rock per day.

Delvigne's safety apparatus.

M. Delvigne, a French officer, the same who is the inventor of a rifle that bears his name, exhibits an apparatus which is a modification, and would seem also an improvement on Captain Manby's mortar for effecting a communication between the shore and a vessel in distress, or between two ships at sea in bad weather. The principal point of difference is, that the line to be conveyed by the projectile instead of being coiled down beside the mortar, and drawn out by the ball, is wound on a reel in the projectile itself, which is thus made of an elongated form, and consequently of a greater weight than a round shell of the same diameter. The end of the line which it is desired to retain is fastened to or near the mortar, and the line unwinds itself from the reel during the flight of the projectile; the advantage of this arrangement is that the shot is relieved from the impediment to its flight, of the resistance offered by uncoiling and drawing through the air the whole length of line, and also that as its velocity diminished, the weight is also decreased at the same time, until at last nothing is left but the envelope or shell, which being of wood will float on the water and buoy the end of the line in the case of its not

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exactly reaching the vessel for which it was intended, and is also less likely to occasion any damage in striking either a ship or objects on shore. This apparatus is so simple in its application as to be easily understood and managed even by unskilled persons, and it can be used not only in cases of shipwreck, but also to carry despatches from one ship to another when the weather is too bad for them to communicate by other means, to take out a tow line at sea, or to afford aid to a man fallen overboard.

Tremblay's safety apparatus.

M. Tremblay, a captain of marine artillery in the French service, is also the inventor of a somewhat similar apparatus, but more powerful than that of M. Delvigne ; it consists of an iron grapnel having its flukes covered by a piece of wood, and with a chain of some yards in length attached to its ring, to the chain is attached the line which it is proposed to carry, which is rolled in a box as in the apparatus of Captain Manby ; the projectile force in this case is a six-pounder or twelve-pounder Congreve rocket. The range of the prejectile in the two systems is pretty nearly the same, namely, from 300 to 400 metres, that is, 327 to 436 English yards ; but the apparatus of M. Tremblay has the advantage in being able to carry out at once a line of half an inch in diameter, whereas the line carried by that of M. Delvigne is not more than half that size ; his grapnel also is better adapted for holding than the reel employed by the latter gentleman. A third exhibitor of apparatus for a similar purpose is a

Pourcher's safety apparatus.

M. Casson Pourcher, who makes use of a small mortar almost identical with that of Captain Manby, now so well known in England.

Anchors.

Several anchors are exhibited, some of them differing in form from the common one ; one of the best appears to be

Trotman's anchor.

that of Mr. Trotman, which has the flukes moveable on a pivot at the crown of the anchor in the same way as in Porter's anchor, on which it claims to be an improvement ; it possesses many advantages, such as convenience of stowage, a non-liability to being fouled or to prick a ship's bottom in shallow water, and from its peculiar form, the fluke not in action assists in strengthening the shank. In the experimental trials which were instituted by the Admiralty, and carried out at Sheerness in 1852, with a view of ascertaining the merits of the many rival anchors exhibited in the Exhibition in 1851, and brought forward about that time, of eight anchors, including the Admiralty pattern, which were submitted to many and severe proofs, those of Mr.

Rodger's anchor.

Trotman and Mr. Rodger, which will be hereafter described, appear to stand first in order of superiority ; their strength

and holding powers being represented by the numbers 1·28 and 1·26, the Admiralty having been adopted as the unit of comparison, and such has been the effect of this verdict upon the maritime public, that since that period Trotman's anchor has been supplied to more than six thousand vessels of all sizes, and it is stated that for an equal strain the weight of the anchor can be reduced more than a fifth by the adoption of this form.

Bloomer's anchor.

An anchor, also with moveable flukes, said to be an improvement on that last mentioned, is exhibited by Messrs. Bloomer and Co., West Bromwich, near Birmingham. The peculiar feature in this anchor is, that the necessity for welding the different parts together is obviated. The arms are made in two separate pieces or plates, which are secured to the shank by a bolt at the crown. The palm and toggle or hone are constructed in one solid piece, the latter being passed through between the plates of the arms and secured to them ; the point of the palm and the two pointed ends of the plates are then welded together at one heat. The shank is of one piece, and is inserted between the plates of the arms, instead of the latter being inserted between two welded jaws of the shank ; thus only two welds are necessary in the construction of this anchor instead of six, which are required in the common anchor. As this anchor was not in existence at the time of the experiments mentioned above, we must wait for some renewal of them, or at least some practical trial before venturing to pronounce on its capabilities as compared with the anchors already tested.

Martini's anchor.

An anchor with flukes also moveable on a pivot at the crown is exhibited by a Frenchman, a M. Martini, but in this, instead of the flukes moving alternately to and from the shank, they both move together to one side or the other, and both bite the ground at the same time ; in some trials that have been made at Marseilles, it is said to have answered well, and it has the advantage of not requiring any stock, and consequently of being easier to stow than a common anchor ; the novelty of the invention is very doubtful, and indeed it is said to have been brought forward and tried entirely without success in this country about 35 years ago.

French naval pattern anchor.

In the open space behind the principal building, two large anchors, side by side, presented very remarkable differences of shape and design ; the one was the anchor at present in use in the French Imperial navy, and differing little, if at all, in general form from that which has been in general use for years for ships both of war and commerce,

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namely, with large flat flukes and round shank and crown. The other is the invention of Mr. Rodger, Lieut. R.N., and differs from the ordinary type in having the flukes extremely small and thick, and the shank and crown rectangular in section, instead of round or oval, the longest side of the rectangle being in the direction of the greatest strain. Mr. Rodger contends that from the flukes of his anchor being small and pointed they enter much deeper into the ground, and consequently give a much greater holding power. The advocates of the old system say, on the other hand, that their flukes, although not biting so deeply as those of Mr. Rodger, yet by their greater breadth offer increased resistance, and that in loose soil or mud the small flukes would be almost useless. The experiments made by the Admiralty have, however, as stated above, invariably given Mr. Rodger's a high place among the anchors tested. A sixth anchor is exhibited by a Mr. Wight, of Sunderland.

Rodger's anchor.

Screw moorings. Saunders and Mitchell.

Under the same head as anchors may be noticed the screw moorings of Messrs. Saunders and Mitchell, which have attracted great attention among the various foreign nautical visitors to the Exhibition. The mooring consists of a single turn of a screw, with a broad flat flange or thread of two or more feet in projection, and having a ring made fast to the axis of the screw, to which is attached the cable. The mooring itself being screwed into the ground they have a much greater holding power than an anchor, but are obviously only applicable to the case of permanent harbour or other moorings, and cannot be brought into competition with anchors for ordinary employment by shipping.

Sisco's chain cables.

A curious description of chain cable is exhibited by a M. Sisco, who, instead of welding the links in the ordinary manner, makes each separate link of a length of rolled hoop iron, wound round and round till it attains the required thickness. It is then plunged into melting brass to braze together the different laminæ of which it is composed, and to fill up the interstices unavoidably left between the folds of hoop iron. It is stated that in experiments made both at the Royal Dockyard at Woolwich and at the French Imperial Dockyard of Guerigny, the strength of these links proved to be enormous, so great, indeed, that it was judged prudent to suspend the experiments through a fear of accident to the hydraulic proving apparatus itself. The objections to its use are, that from the union of brass and iron it is probable that in salt water the latter would suffer so materially from galvanic action as to be entirely destroyed

in a very short time; that the links, from the form of their section, which is, from the method of manufacture, necessarily rectangular instead of round, are certain to cut one another when under heavy strain; and a third objection lies in the very much increased cost of a chain of this description. A fourth objection may be stated, which was elicited in the Exhibition itself; it is the ease with which defective workmanship may be introduced into this description of chain without a possibility of detection, except by actual trial. At the time when the experiments were being carried on in the Exhibition upon the strength of specimens of wood from British Colonies, a link of this chain was brought, with a statement that it had broken the Woolwich hydraulic press, and with a request that it might be tried upon the one then being used; in other words, that permission might be given to break that one also. This was declined, as the machine, belonging to Mr. Dunn of Manchester, and with great kindness placed at the disposal of the British Commission, although a very beautiful one, was not intended for testing strains such as the "chain Sisco," was said to be able to bear. At the same time an offer was made to try a somewhat smaller link, of apparently equal workmanship, which formed part of the Exhibition, of M. Sisco, who, however, refused to allow such trial, on the ground that these small links were merely made for exhibition, and that their workmanship was not of such a character as to enable them to stand any great strain; thus furnishing, as it was thought at the time, a powerful objection to the system advocated. Good specimens of chain cable were sent by Messrs. Edge and Son, Coalport, and by Messrs. Smith and Hawkes, of Birmingham, and it is much to be regretted that no trial was made of the comparative strengths of the chain cables contributed by different manufacturers, without which any attempt to pronounce upon their comparative merits must be largely influenced by the known character of the houses exhibiting them, and any opportunity that might thus be afforded for the acquirement of additional knowledge by such means thus allowed to pass unimproved.

English chain cables.

Almost the only French maker of chain cables, M. David, of Havre, and who is also the only exhibitor from that country, shows, besides chains, several inventions or improvements in nautical machinery, which appear deserving of notice. The first of these he calls a "lunette d'escargot." It is for the purpose of preventing the turns of a rope from mounting up to the top of the barrel of the capstan, and in consequence necessitating the rope to be stop-

French chain cables.

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pered while they are being driven down again, and the means by which this is accomplished is simply by a ring of iron, which is put on the barrel of the capstan, fitting quite loosely, so as to turn freely on the latter. One side, or rather one point, in the circumference of this circle rests on a shoulder at the bottom of the barrel, while another diametrically opposite is kept slightly tilted up by a small roller on this shoulder, and by the inclination of this guiding ring the rope going on the barrel is made to follow a course somewhat like the thread of a screw, and instead of mounting at each turn a space equal to its own diameter, the turns are kept constantly at one part of the barrel.

David's steering wheel.

M. David has applied the same principle to the winding of the tiller ropes or chains on the barrel of the steering wheel, and exhibits the steering apparatus thus constructed, for which he claims this important advantage, namely, that both the ropes or chains being constantly and evenly stretched, there is no slack to be taken up, and consequently no lost time in changing the motion of the wheel from one direction to another.

Barbotin's capstan.

A capstan, much in use and greatly esteemed in the French naval service, is that invented by Captain Barbotin, of the Imperial navy, the peculiarity of which consists in its having a part of its barrel sunk so as exactly to fit each link of the cable, which can thus be brought in without being obliged to employ a messenger, as at present.

Saxeby's stopper.

A very simple and apparently effective stopper, a kind of small break, is shown by its inventor, Mr. Saxeby, which, from its extreme simplicity, seems to bid fair to take the place of the one now so much employed, invented by Captain Legoff, of the French navy.

Gray's anchor-dropper and scuttles.

Mr. Gray, Limehouse, the exhibitor of Sir William S. Harris' lightning-conductors, has also a variety of small objects appertaining to the fitting of ships. One of these is a method of securing an anchor at the cathead, so that it can be let go by simply pulling a trigger inside the bulwarks, something in the way that the life buoy is let go on board a man-of-war. He also shows some neat methods of securing scuttles, and some improvements in the fitting of deck lights, so as to open if required, and at the same time to be perfectly water-tight, small matters apparently, but which will hardly be underrated by anyone who has made a voyage with a defective scuttle opening into his berth, particularly in bad weather. Another of Mr. Gray's inventions

Gray's ship's pump.

appears in the shape of a ship's pump, to which he has given the name of spherical, from the barrel, if it may be so called,

of the pump being in the form of a sphere instead of cylindrical. This sphere is divided into two equal parts by a vertical partition, leaving a small space at the centre for the reception of the piston, which is a circular disc placed horizontally across the centre of the sphere. This piston oscillating on its diameter in the plane of the partition above mentioned makes alternate up and down strokes as it were in the two hemispheres, so that it is in point of fact a peculiar form of double pump. The action of pumping is rotary, and performed by a winch. The chief merit of the pump would appear to consist in its neat, compact form, and the very small space occupied by it both when at rest and when being worked. It may be mentioned that Mr. Gray exhibited a steam-engine of 12-horse power on the same principle, which worked satisfactorily during the whole period of the Exhibition.

Among the nautical objects placed on the trophy of the British mercantile marine were some models to illustrate a very neat method of shipping and unshipping a boat's rudder, which is said to have been applied and approved of in some of the coastguard boats, and the inventor proposes to extend the principle to ships' rudders, which he hopes thus to render capable of being more easily repaired in case of accident. His plan is to make the rudder slide in grooves formed in the sternpost of the vessel, so as that it can be unshipped by lifting it and removing it from the groove. It does not appear that any application of it has been made on a large scale, and it would seem to be extremely difficult to strengthen the grooves sufficiently to resist the action of the sea.

Peculiar rudder by Cockerill, from Belgium.

A sternpost and skeleton of a rudder for a screw steamer, being a fine forging of wrought-iron, are sent from the works of Mr. Cockerill, at Seraing, in Belgium, and show a very curious arrangement, the object of which is difficult to conjecture, the screw is placed abaft the rudder, which is necessarily cut in two to admit of the passage of the shaft, for which purpose the rudder post has an eye in the centre through which the shaft works, and which is made sufficiently large to admit of the play of the rudder; the effect of such an arrangement would seem to be to weaken the rudder, render it difficult to be unshipped for repairs and deprive it of the advantage which it may gain from the more rapid action of the water in its passage from the screw.

Dutch hollow iron mast.

A nicely constructed model in the Dutch department shows a method of substituting iron for wood in the masts of a ship; the model in question is that of a wrought-iron

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tubular mast, being the mainmast of a 1,000 ton ship, in external form it is precisely the same as a wooden mast, and is said to be much stronger and lighter, the full sized mast of which this is a model only weighing five tons, it is formed of iron plates rivetted together, but as no description or section accompanied the model, its internal structure cannot be stated.

Several means are exhibited of lowering ships' boats, among which two seem especially deserving of notice, one by a Mr. G. F. Russel and the other by Mr. Clifford, in the former plan the boat rests her whole weight upon two keel cranes; the act of lowering immediately disengages her from them without hoisting the boat, and at the same time projects the boat several extra feet from the ship's side, and as both the pendents, after passing over the heads of the cranes, lead to the same barrel of the winch, both ends of the boat must necessarily be lowered simultaneously, and when near the water, one man in the boat can instantly disengage her fore and aft by a lever under the centre thwart, which releases a clip at either end of the boat that holds the hook of the tackle. The winch for lowering and raising the boat is placed flush with the stanchions inside the bulwarks, these occupying no space on deck; it is fitted with a break, so that one man can lower a boatload of people, or by a lanyard to the break a man in the boat can lower it, however heavy, and regulate its descent without anyone remaining on deck. In Mr. Clifford's boat the tackle falls are led to a winch under the centre thwart of the boat herself, and by releasing a break and permitting this to revolve, the boat is lowered evenly and gently by a hand in the boat itself.

Russel's apparatus for lowering boats.

Clifford's apparatus for lowering boats.

Berthon's life-boat.

A beautiful ship's life-boat is the invention of the Rev. Mr. Berthon, of Fareham, Hants, a model of it was placed in exhibition, and a full-sized boat was afterwards brought over from England, and made the subject of some very severe trials, as to stability and strength, on the Seine, in the presence of H.I.H. the Prince Napoleon and the Members of the Jury, in all of which her performance was most satisfactory. The boat is the form of a whale-boat, that is, sharp both bow and stern, and is constructed with longitudinal timbers instead of transverse, the gunwales being the uppermost pair of these timbers, and the keel the lowest; these timbers are moveable on pivots at the upper part of the stem and stern, so as to be capable of being folded down on either side of the keel, the planking, if it may so be called, is formed of two skins of waterproof canvass stretched over

these timbers, one inside and the other outside, thus forming air-cells between the timbers when the boat is stretched out; the bottom boards and thwarts are hinged in the middle, so as to fold with the boat, and the oars are fastened to the latter, so as to be always ready for use. The boat when folded up occupies only a few inches in breadth, and is stowed close to the ship's side outside the bulwarks, covered by a cloth of painted canvass, and attached to a pair of light davits so constructed that she can be lowered in a few seconds, and the weight of the boat being thrown on the spanners attached to the gunwales, she is opened into her boat-like form by the mere action of lowering. This boat is not more heavy or costly than an ordinary wooden boat, and as a ship might carry six or seven in the space now occupied by one ordinary ship's boat of the same size, would appear to be peculiarly adapted for emigrant ships, &c., where space is valuable and plenty of good boat accommodation indispensable. A portable boat is exhibited in the American section on a different principle to that of Mr. Berthon. The form of the boat is flat-bottomed, square at each end, and with flat sides sloping outwards. The sides and ends are hinged on to the bottom, and the joint kept water-tight with india-rubber cloth, and when not in use they can be folded down on the bottom so as to form one flat package. The angles between the sides and ends being also connected with india-rubber cloth, are fastened together at the angles by a small hook, so as to form an ugly shaped punt, certainly quite unfit for any purposes, either of a ship's boat or life-boat, and only capable of being used in perfectly smooth water, and propelled at a very slow rate.

American life-boat.

Another form of portable boat is shown among the French naval models, the material of which seems novel in its application, it is made of a rectangular flat piece of wire gauze (*toile metallique*), which is made into a shape somewhat resembling a canoe by being simply doubled up in the middle, the ends being fastened to iron laths which fold in half and form the bow and stern posts. This boat was tried on the Seine, but although simple and ingenious, does not appear likely to be of any practical utility.

French portable boat.

An india-rubber portable boat was exhibited in the English section by Mr. Edmiston, and a similar one in the American part of the Exhibition, both of which are without rigid framework, and are simply dependant upon the inflation of the india-rubber bags, of which their sides are composed, for their form and rigidity, a fact which appears to present a serious objection to their employment, as a boat

Edmiston's india-rubber boat.

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on this principle requires to be kept not merely waterproof, but what is infinitely more difficult, air-tight; a leak, however small, instead of being merely an inconvenience to be overcome by bailing, is destructive to the boat, and further, a leak above water is of as much consequence as one below; in one of the india-rubber portable boats an attempt has been made to remedy this evil by introducing a light folding wooden framework, which appears a decided improvement upon the plan of trusting entirely to inflated bags. The Americans show in the same collection with this two long cigar-shaped india-rubber air-vessels, constructed for the purpose of being lashed to the gunwales of a common ship's boat, with a view of making her more difficult to capsize, and of giving her sufficient powers of flotation to support her crew in case of her getting wholly or partially filled with water, in fact, to give a means of extemporizing a kind of life-boat in case of emergency out of an ordinary boat; these air-vessels, are of course, liable in some degree to the inconvenience mentioned in speaking of the last named boat, but as only supplementary flotation is required of them, and they are not depended on for rigidity, the evil becomes much less than in the former case.

Thompson's life buoys.

Another American, a Mr. Thompson, has an ingenious method of converting the deck seats for a passenger vessel into life-buoys. He makes the seats a kind of ottoman, which, by their form, are capable of embracing a person's body under the arms, and the seat and legs being full of air, give sufficient power of flotation for one person.

Canadian safety paddle-box.

In the Canadian collection is a model showing how the outside part of the great paddleboxes of the river and lake steamers employed in America can be instantly detached from the vessel in the case of accident, and so constructed as to form large rafts capable of sustaining each a great number of persons. They are only fastened to the rest of the paddleboxes by two bolts, which, on being withdrawn, allow them to fall off into the water, their detachment being facilitated in case of the vessel sinking by the outward pressure of the air contained under the paddleboxes.

Burch's life-boat.

Perhaps the most wholesale way of providing life-boat accommodation for ships is that proposed by Mr. Burch, of Macclesfield, the inventor of a form of screw propeller, hereafter to be described, and shown by him in a model of a first-class steamer; this is no less than to construct the poop of the ship as a separate vessel, capable of being detached and launched from the ship's deck at a moment's notice, but

which is stated to be as firmly secured to the rest of the ship at all other times as if built as a permanent poop. The mizen-mast of the parent vessel is stepped in the poop, so as to form a mast for it when detached, and it is likewise furnished with a rudder and bowsprit, and has the appearance of a cutter-rigged vessel. The idea is ingenious, and prettily carried out; but the difficulty of securing the separate poop to the main vessel would appear to be so great as to render its practical application of very doubtful success.

Smith's life-belts.

Cork life-belts and buoys are contributed by Mr. Smith, Fish Street Hill, London; and also by a M. Crignies, of Amiens; and the same articles in india-rubber by almost all the exhibitors of that class of goods.

Coast life-boats.

Shore or coast life-boats, which formed such a large item in the Exhibition of 1851, owing to the competition for the prize so munificently offered by the Duke of Northumberland, had but few representatives in the Exhibition of 1855, the Royal National Life-boat Institution and one or two private individuals being the only contributors from England.

Belgian iron life-boat.

From Belgium there is a boat constructed of iron, and said to be for the purposes of either a fishing or a life-boat. It has an air vessel at each end, all along each side, and the spaces under the thwarts form also additional air-cells; in fact, the interior space of the boat seems unnecessarily diminished for the purpose of creating superfluous buoyancy, while there is no provision for enabling the boat to right herself if upset. It may be added, that nothing can be more unsightly and more unlike a serviceable sea-going boat in form, and her whole appearance seems to warrant the idea that she would be most unfit for either of the purposes for which she is said to be designed. A curious novelty in the construction of this boat is that she is fitted all round the gunwales with fenders made like elliptic carriage-springs.

Moué's life-boat.

A full-sized life-boat, invented by M. Moué, of Havre, is shown in the garden behind the Palais de l'Industrie. It is of wood, thirty feet long, six feet beam, and four feet deep; it has a large air-vessel at each end, but without having the air-vessels so much elevated by the sheer of the boat as in Beechy's and Peak's life-boats. Instead of having air-vessels or compartments along both sides or under a false bottom, she is constructed with an air-vessel immediately below the gunwale on one side only, which is said to have the effect of making her right very rapidly when upset. The boat in question, in some trials which were carried on at Havre, is said to have righted instantly with three men and a weight of 300 kilogrammes (660 lbs.) on board; but as she

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was not among the boats experimented upon in the Seine at the time of the Exhibition, no further particulars can be given of her performances.

Screw propellers.

As might be anticipated, there are a good many competitors for the best form of screw propeller; some professing to have improved upon the one in common use as regards its propulsive effect, and others exhibiting alterations in the method of withdrawing or feathering it when not in use. To judge from the models exhibited, each claiming for itself some peculiar advantage, there would appear to be considerable difference of opinion on the best and most effective form of screw, as we find some so widely differing from others in appearance, that it is difficult to suppose they can be intended for the same purpose. Thus we find six-armed, four-armed, three and two-armed screws, screws with straight and curved, long and short, broad and narrow, fixed and moveable arms, several forms and dimensions of centre or bosses from which the arms project, and various contrivances for getting rid of the propeller when the vessel is under canvass alone.

Sollier's screw.

In a propeller invented by a M. Sollier, a marine engineer in the French service, he starts with the axiom that a screw with four arms is that which up to the present time has given the best effect in propelling, and devotes his attention to the means of overcoming a very serious objection to such a form, particularly for ships of war, viz., the difficulty of withdrawing the screw from the water, owing to the impossibility of providing a well of sufficient dimensions for its reception; this he proposes to effect by the employment of a four-bladed propeller which is composed of two separate two-bladed ones set on the same axis at right-angles to each other, and so disposed that by means of internal mechanism they can be brought at pleasure, the one pair of arms in front of the others, forming as it were a two bladed screw, and capable of being hoisted up a well of nearly the same size. This system of propeller is fitted on board the "Austerlitz," a ship of one hundred guns in the Imperial Navy, and is said to have worked satisfactorily during the two summers that she has been employed in the Baltic. It is, however, subject to the grave objection of being complicated in its mechanical arrangement, which, always to be avoided, is increased tenfold when applied to any machinery working under water, and consequently extremely difficult of access for the purposes of adjustment or repairs.

Mangin's screw.

Another form of propeller, partially adopted by the Imperial navy, is that invented by a M. Mangin, also a marine

engineer in that service, and which one might fancy had been suggested by that last described, as it consists also of a combination of two two-bladed screws set on the same axis, but instead of being moveable thereon, they are fixed in the position that M. Sollier adopts for enabling his propeller to be lifted into the well. The two screws, cast in one piece, are placed in the example shown (which is intended for the "Imperial," a ninety-gun ship) at twenty inches apart, the one before the other, so that they have but one projection on a vertical plane, at right angles to the vessel's keel; each separate blade is, of course, considerably less in width (apparently about one-half narrower) than that of a two-bladed screw of similar diameter, from which it follows that a well of one-half the width is required for its reception when elevated, an important point in a ship of the line, where it is desirable to leave as much space as possible for the stern chasers. M. Mangin's system was first tried in 1853, in the steam sloop "Marceau," of 120-horse power, and was found to have rather the advantage over the two-bladed screw in its traction from a fixed point. In propelling the ship it gave, with the same number of revolutions of the engine, identical results with the ordinary screw, both as to quickness and slip, but with a trifling increase in the power employed, which being so small as only to affect the third place of decimals of the co-efficient of useful effect, was supposed to have been occasioned by the greater friction of the new propeller, it being of cast-iron while the two-bladed one against which it was tried, was of polished gun-metal. One remarkable and unexpected result was observed on this trial, viz., that with M. Mangin's propeller there was an almost total absence of all tremulous motion.

The system of M. Mangin was applied to the "Phlégéton" corvette of 400-horse power, and so satisfactory has been its performance in the Baltic and Black Sea, that the present example is destined, as before stated, for a line of battle ship. Perhaps the most important advantage resulting from the employment of this propeller is, that from the blades barely exceeding the stern-post in width (in the "Phlégéton" the projection on each side is only five inches), the vessel can be put under canvass without lifting, or in any way altering, the position of the screw, except merely to place it in a vertical position.

Holm's propeller.

A propeller is exhibited by Mr. John Bourne, of Greenock, and also by the inventor, M. Holm, to which he has given the name of heliocoidal propeller, the blades of which are curved at the ends, so as to present a concave

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surface on the afterside, which is said to have the effect of preventing the centrifugal motion given by the revolution of the screw, and to change its direction into one parallel to the axis. The system has been applied in two instances in Sweden, and has also been employed in the case of the "Alma" transport, and in four other vessels, by Mr. Bourne, it is said with good results. In one of these in the Exhibition, the blades are shown curved also in a contrary direction, for the purpose of going astern as well as ahead; but as it is seldom that great speed is a matter of consequence in such a case, this would appear a complication of rather doubtful advantage.

Burch's propeller.

Two propellers exhibited, one by Mr. Burch, of Macclesfield, the other by Mr. Allen, seem to have arrived in different ways almost at the same form, the object in both is to get rid of the dead circle, or that part of the imaginary disc formed by the revolution of the screw, in which little or no propulsive effort being exerted, its power is expended in merely beating or churning the water, and consequently detracts from the speed of the vessel. In Griffith's propeller this is sought to be counteracted by filling up the dead circle solid, in the form of a sphere; and Mr. Burch and

Allen's propeller.

Mr. Allen follow out the same principle, only that with them the run of the vessel is made to project in a kind of cylindrical form, so as to cover this centre part of the propeller, by them made disc-shaped instead of spherical; and the taper or curve of this projecting part of the vessel is carried out to a point, so as to give it a clean run; and it is in the manner of effecting this latter object that is contained the principal difference between the two propellers, Mr. Burch bringing the screw further forward, making the run in the dead wood of the vessel, while Mr. Allen places his propeller abaft the sternpost, and produces a similar form by a prolongation of its centre boss. Of the two, that of Mr. Burch appears to be the most practicable; and as he has since actually applied it to a small vessel of his own construction, it is to be hoped that some account will be given of the results of this enterprising experiment. The propeller is inserted in a space left for the purpose in the dead wood, as in the ordinary screw, but considerably further forward, the cylindrical projection before mentioned being also cut through in a transverse direction to receive the disc or boss which fills up the dead circle of the propeller. The blades or vanes, six in number, project from the circumference of this disc, and are so constructed that they can be entirely drawn into it when the screw is not in use. In

order to prevent the friction and loss of power which would otherwise take place from the rapid motion of the disc in the thin films of water contained between it and the cylindrical part of the run, a small tube, connected with this space, is led out above the water line of the vessel, and the air thus admitted takes the place of the water, which is driven out by centrifugal force.

Tod and Macgregor's model of the "Simla's" screw and engines.

A model of the screw of the steam transport "Simla" was exhibited by Messrs. Tod and Macgregor, of Glasgow. It is three-bladed, and made of cast-iron, and is attached to a pair of 25-horse power engines, being an exact model of those of the vessel above named. They are of the kind denominated steeple engines, which form has long been used on the Clyde in paddle steamers, and which is here modified to suit the altered method of propulsion. In these the cylinders are vertical, and set fore and aft over the keel, each having four piston rods, between which is placed the crank shaft, close to the cylinder covers; the motion is communicated through gearing, the screw making three revolutions for each one made by the crank shaft.

De Bergue's propeller.

Among the marine propellers, one by an English exhibitor, Mr. De Bergue, bears the stamp of originality, but as it does not appear that any actual application, or even experiment, has been made, it is not possible to pronounce on its merits. Although it so far resembles the screw propeller as that it acts obliquely on the water instead of directly, as is the case with the paddle, yet in its actual application it resembles more the latter propeller, being situated in boxes or chambers on either side of the ship, and the power being derived from paddle-engines. The propeller consists of a long flat pallet of wood or other material, the length of which is about five times its breadth, lying horizontally in a square tube or chamber of nearly the same length and breadth as itself, parallel to the vessel's keel. To understand the action of the pallet, let it be supposed to be in such a position as to form a diagonal of the box or chamber, its foremost end touching the top, and its aftermost the bottom of the chamber. If the after end be now raised to the top of the chamber, keeping the fore end in its present position (the pallet turning on it, as it were), a wedge-shaped portion of water will be forced out behind, and at the same time there will be a tendency to draw in the water from the front to the space left by this wedge, bounded by the pallet. The front end being now in turn brought to the bottom, leaving the aftermost at the top, an oblique action will take place on the water in the chamber,

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nearly similar to that exercised by the blade of the screw propeller; and on the after end being also brought down, the wedge-like action first described will again take place. It would appear then that there are two distinct propulsive actions on the water in each stroke, which may be said to bear respectively the same relation to the screw propeller as the wedge and inclined plane bear to its namesake among mechanical powers, where, as is well known, their relationship is very intimate. Mr. De Bergue proposes to place his propeller either on each side the ship, or in a trunk in the middle; and there are instances in which it would probably supersede the screw with advantage,—as on canals or shallow rivers, where the latter is with difficulty applied; it would also, perhaps, be free from the objection of getting fouled by ropes, &c., to which the screw is in some measure liable, and which has, in some instances, led to other means of propulsion being adopted, as, for example, in the floating fire-engine now in use by the London Fire Brigade, where this inconvenience is remedied, at a great expense of power, by substituting for the screw propeller the direct action of a stream of water, propelled by a centrifugal pump in the vessel's hold.

Corbett's multiplying gear.

In connexion with the screw propeller may be mentioned a pretty means of multiplying motion exhibited by a Mr. Reginald Corbett, which he proposes to make use of for transmitting the power of the engine to the screw, without being obliged to have recourse to gearing; in the specimen shown the velocity is doubled, the driving shaft has a flat disc of metal on its end, with three slots or grooves on its face reaching entirely across it, forming six equi-distant radii; three friction rollers at the extremities of the same number of equi-distant arms on the end of the shaft of transmission work in these slots, acting in a similar manner to the teeth in wheel and pinion work, the apparatus being, in point of fact, a three-toothed pinion working into a six-toothed wheel.

Paddle wheels.

The growing ascendancy of the screw over the paddle, as a means of marine locomotion, was exemplified by a remarkable absence of anything novel connected with, and, in fact, almost of any example of the ordinary paddle wheel; some revivals of long abandoned schemes, indeed, appeared under this head in the French part of the Exhibition, and a small model of a feathering paddle in the Austrian section of the Annexe, but as regards anything either novel, suggestive, or practical, the paddle was wholly without representation.

Models of ships.

Two models of vessels on a large scale which were deemed

worthy of a place in the great nave of the Exhibition attracted particular attention, one was a sectional model of an Australian passenger sailing ship, the "James Baines," of Liverpool, exhibited by the firm of that name, and having all the stowage and accommodation shown in the greatest detail, and the other was a completely rigged model of one of the large passenger steamers belonging to the great French Company of the Messageries Impériales; and as a model, far surpassing anything of the kind in the Exhibition; not only was the minutest detail given, on deck, in the rigging, and on the exterior of the hull of the ship, but she was also made to draw apart amidships and draw asunder, so as to show a beautiful and complete working model of her engines and machinery, which during the time of the Exhibition was moved by a train of clockwork. The Company who exhibited this work of art, for such it might truly be said to be, occupies a position very different from any of the great steam companies of England or the United States, for they are not only shipowners and carriers, but also shipbuilders and engine and boiler makers on a very large scale. Unlike the English and American Companies, which can depend upon the resources and competition of private establishments, both for construction and extensive repairs, the French Company, from the absence of such establishments in France, is obliged to depend entirely on its own resources for all its requirements, and has to organize for this purpose two complete dockyards at Marseilles and at Ciotat, which are of such extent as to be capable of building, constructing machinery for, keeping in repair, and fitting out in every respect the entire fleet engaged in the Mediterranean French postal service. This service was handed over by the French Government to the Company in 1851, together with 16 old steamers propelled by an aggregate of 2,980 horse-power, and the Company now possesses (1855) a fleet of 46 vessels of, in all, 10,100 horse-power, without reckoning several chartered vessels employed in their service; the number of sailors in their pay, which in 1851 was 626, had increased in 1855 to 2,292; all the engineers are French, and almost the whole of them have been promoted from among the apprentices at the Company's works at Ciotat. The number of civil passengers has increased in two years from 27,000 to 43,000, and the merchandise carried has doubled in the same time, being now 18,000 tons; in addition to this the Messageries Impériales have transported, from the commencement of the war up to June 1855, 130,000 men and 19,000 tons of

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Model of the "James Baines."

French mail steamer.

French Company of the Messageries Impériales.

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warlike material and stores to Africa and to the East. The establishment of Ciotat, purchased in 1851 for 25,000*l.*, is, in 1855, valued at 80,000*l.*, and it has produced in that time five new vessels without counting four others in progress of construction; the number of artizans employed is about 1,600, and it is gratifying to learn that the Company have spared neither trouble nor expense in providing for the comforts and wants of their workmen, and that model lodging-houses, gratuitous medical aid, and the means of education, both for children and adults, are provided on the most liberal scale and on the most approved systems, after a careful inquiry in Belgium, England, and France; the Company are now constructing a branch dockyard and dry dock at Constantinople to meet the demands of their increasing traffic in the East.

Scott Russell's great ship.

Among the models of vessels and systems of naval construction, the first in size, importance, and also for novelty of principle, is certainly the monster ship now being built by Mr. Scott Russell for the Eastern Steam Navigation Company. The model is accompanied by photographic drawings of parts of the vessel, showing the details of the bulkheads, and also the progress made in building. There are also shown actual specimens of the double bottom of boiler-plate, which is one of the peculiarities of the vessel's construction. This enormous ship is divided by strong iron bulkheads into ten air and water-tight compartments, and the entire hull is formed of two skins of iron plate, at a distance apart of about three feet, and connected together and strengthened by small partitions, forming the space between them into small cells; this arrangement, with the transverse bulkheads, and two longitudinal partitions running the whole length of the ship, and reaching from her bottom to the upper deck, is substituted for the ordinary construction with keel and timbers. The ship is to be propelled by both screw and paddles, with engines of a collective power of 2,500 horses; her length will be 680 feet, and her burthen in tons, 22,500.

In addition to the model of the "big ship," Mr. Scott Russell exhibits a number of others, all more or less possessing the peculiar form of bow to which he has given the name of the wave line, among which are the models of his celebrated steamer the "Wave Queen," and of the steam gun-boats built by him for the Prussian service, and which have since been purchased by the English Government.

Models of steamers by Napier.

Collections of beautiful models are also exhibited by Mr. Robert Napier, of Glasgow, the constructor of the "Persia," supposed to be the fastest sea-going steamer afloat; by Mr.

Mare, of Blackwall, and by Mr. Samuda, among which may be mentioned those of the now far-famed "Himalaya," the ill-fated "Prince," as well as the "Golden Fleece," the "Croesus," the "Emeu," and many others whose names have become familiar from their being associated with many acts of the late war. One of the models, which excited especial interest, was that of the Russian frigate "Vladimir," which issued from the yard of Mr. Mare, and alone, of all the Russian navy, gained herself a reputation in the war, and terminated her short career beneath the waters of the harbour of Sebastopol. The collection of models of sailing vessels sent by the local committee of Sunderland, although beautiful as models, and exhibited in a trophy of much pretension, does not appear to aim at the illustration of any novelty of form or construction, but is merely a specimen of the class of vessels usually constructed at that port. An exception must, however, be made in favour of Mr. Hedley's "Napoleon," of which a skeleton model shows the peculiar method of construction adopted by this builder, which consists principally in having the bow timbers or frames inclining forward, and those abaft the midship section similarly inclined towards the stern, the midship frame alone being vertical.

Mare's models.

Sunderland models.

Canada is the only one of the British colonies that sends any models of vessels. Mr. Lee, of Quebec, the constructer of the famous sailing clippers, "Marco Polo" and "Shooting Star," exhibiting models of this class of vessels.

Canadian models.

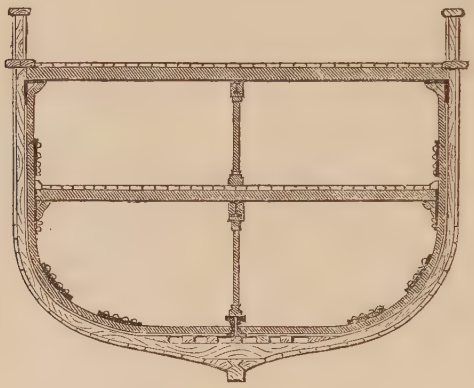
A good many of the French shipbuilders are exhibitors in this section, the principal of whom appears to be M. Arman of Bordeaux, who sends two models to illustrate his novel and very beautiful mode of a mixed iron and wood framing for ships. His method of construction is to reduce the scantling of the timbers, and to strengthen them by internal diagonal braces alternately of wood and iron, reaching from the kelson to the deck-beams, and bolted to the timbers. These, as well as the stanchions, knees, and keelson, are of rolled iron, and the strength of the hull is still further increased by introduction of four or more longitudinal strings, also of rolled iron, rivetted to the iron diagonal braces, the spaces between them being left open for the convenience of inspecting and painting the framing. The keel, timbers, planking, and decks are of wood, and the planking is fastened to the timbers by bolts and trenails, as in ordinary wooden constructions. This system is said to have the advantage of reducing the weight of the hull very much below that of a vessel built of wood, and at the same time giving it all the

French models of ships.

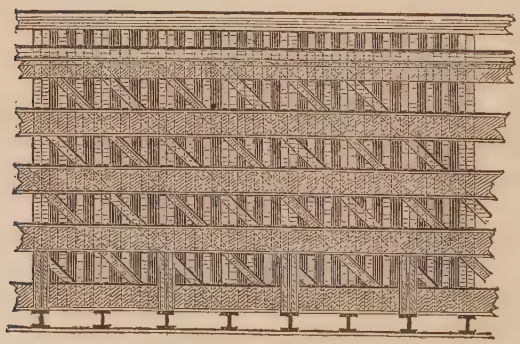
Arman's mixed construction.

Details of M. Arman's Mixed Wood and Iron Construction.

Transverse Section.



Interior Elevation of one side.



strength and rigidity of iron, without its accompanying defects. It enables vessels navigating tropical seas to be protected with copper, and it seems to overcome the objections hitherto deemed insurmountable against employing iron for the construction of ships of war, that of the damage done to the external plates of iron ships by being struck by shot. M. Arman has succeeded in reducing the weight of the hull to thirty per cent. of the total displacement. He has constructed on this principle since 1852, the period of his invention, thirty-three vessels, representing a tonnage of 25,869 tons, and a capital of more than half a million sterling, five of which are steamers; and he accompanies his models with numerous reports and testimonials of the extraordinary strength, tightness, and other good qualifications of the vessels of his construction.

Guibert's construction.

M. Guibert, of Bordeaux, also exhibits a mixed wood and iron construction, in which the framing is entirely of wrought iron, the planking alone being of wood.

Models from Dunkerque and Havre.

Messrs. Vaudezande and Segariz of Dunkerque show models of clipper ships, and smaller vessels are represented by M. Cardon of Honfleur. Both of these are builders in wood; the only one of the French builders who seems to enter to any extent into the construction of iron vessels being M. Nillus, of Havre, also an exhibitor.

United States models.

From the United States dockyards we have models of some of the sailing vessels of the navy, including the "Delaware" and "North Carolina," each of 90 guns; two 44-gun frigates, the "Savannah" and "Potomac," the corvette "Albany" and the 10-gun brig "American," none of them apparently among the latest constructions, while their more recently built war steamers and the merchant navy are left entirely unrepresented.

Maskell's system of sliding keel, &c.

Mr. Maskell, a member of the bar in one of the southern states of the Union, has a model of a sailing corvette of very peculiar form, capable of giving great capacity, and it is said also great speed with a very light draught of water, the vessel in question being 180 feet long with a draught of only 7 feet, for the purpose of making the vessel more weatherly. She is furnished with a sliding keel, also the invention of Mr. Maskell, which when let down will give her a draught of 9 feet; it is called by the inventor a toggle keel, and consists of galvanised iron jointed together in three lengths; the centre one of which rises and falls parallel to the keel, while the two end ones being suspended to pivots in the keel passing through slots at their extremities, serve to

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connect the main piece with the standing keel; the apparatus is raised or lowered by means of rods passing up through the vessel's centre to the level of the deck, and worked by rack and pinion, and the sliding keel when raised is contained in a groove formed for the purpose in the main keel. The model of this corvette is thought by nautical men to possess some valuable points, and might possibly be suggestive of something useful in cases where it might be desirable to combine heavy armament with extremely light draught of water, as in the case of the late operations in the Baltic; the sliding keel seems liable to the objections against all such apparatus, viz., the almost certainty of being injured in case of the vessel touching ground, and the difficulty of repair even in a dry dock.

Other foreign models.

The only other countries contributing under this head are Austria, Holland, and Greece; the former being represented by Messrs. Brazzoduro of Trieste, who send several very pretty models of clippers.

Greek shipping.

From Greece there is a handsome rigged model of a frigate, by M. Kiriakon, of the island of Spezzia, the only exhibitor among the Greek shipbuilders, who are said to build ships at a lower price than those of any other part of the world. Since the separation of Greece from the Turkish rule, the increase of her commercial marine has been most remarkable; thus, in 1821, under the dominion of Turkey, Greece possessed but 440 vessels; in 1834, after her liberation, she had already 2,900; and at present the number of vessels has increased to 4,200, with an aggregate tonnage of 425,000 tons, and manned by 27,500 sailors.

Dutch gunboats.

The Netherlands Minister of Marine sends a model of a line of battle ship, with a large wooden float or camel attached at each side, for the purpose of floating her over shallows; also a model of the mortar vessel in use in the Dutch service, with the mortar bed on a turntable amidships and magazine underneath. Judging from the appearance of the models, the Dutch gunboats do not seem constructed for very rapid locomotion,—models of both a first class and second class gunboat are shown; they are both of a very clumsy build; the first carries one gun forward and two aft, on ordinary ship carriages, and a mortar amidships; the second class is similar, but without the mortar; the bulwarks of both vessels seem inconveniently high; they are sloop rigged, very flat in the floor, and fitted with lee-boards. There is also exhibited a model of a rowing gunboat, pulling twenty-two oars, and having two

masts rigged with sprit-sails; she carries one gun forward, on a ship carriage, and a carronade aft, on a slide traversing on a front pivot. CAPT. FOWKE ON NAVAL CONSTRUCTIONS.

Models of a Texel pilot sloop, and of a pilot-boat with sprit-sails and oars, used at the mouth of the Meuse, complete the collection.

M. Rickmers of Bremen exhibits a model of the sailing ship "Ida Ziegler," of 1,200 tons, of which it is stated that her length is 220 feet, breadth 40 feet, and that she was built in 110 days. This, with a model by M. Kierkegaard, of Gottenburg, completes the exhibition of models of vessels intended for the purposes of maritime navigation. Model from Bremen.

In the section referring to vessels constructed for river navigation, a model of one of the far-famed Hudson river steamers has attracted much attention from its remarkable difference from all other nautical models; it is a model of a class of steamers running from New York to Albany, some of them measuring as much as from 350 to 400 feet in length, by 30 to 36 feet in breadth, and from their great length drawing not more than 4 feet to 4 feet 6 inches water. They are all paddle steamers, the light draught not permitting the employment of the screw, and the diameter and breadth of these paddle wheels is very much greater than any that are used on this side of the Atlantic, in some cases reaching as high as 45 feet in diameter, with 15 or 16 feet length of float-board; but a very small part of the accommodation of these vessels is contained in the hull properly so called, the principal part being in a sort of two-story house, as it were, built on deck; the actual hull is generally devoted to a great dining saloon, surrounded by three tiers of berths, and the bar and steward's offices, being nearly clear from end to end; the deck over this stretches out very far beyond the ship in width, the bulwarks generally running in line with the outside of the paddle boxes; on this deck, at the after part, is built a large sleeping and sitting cabin devoted to ladies only; at the bow is an open space for baggage, &c.; the boilers, and furnaces with their accompanying funnels, are placed clear of the ship out on the sponsons abaft the paddle boxes. The single engine is in a small engine-room on this deck, along the sides are the various offices for issuing tickets, and for carrying on the business of the ship, the kitchens, &c., and above this is the great saloon deck, the roof of which extends from bow to stern, a part is left open at the sides for some 50 feet at each end of the ship, and fitted up with every convenience of chairs and sofas, and the remaining part forms an immense saloon uninterrupted from end to Hudson river steamer.

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end, save by two small cases in which move the piston rod and connecting rod of the engine; this saloon is lighted from the roof, and is flanked on either side for its whole length by a row of state cabins, for the use of those who choose to pay a trifling addition to their fare for this convenience. The deck over this is simply a wooden roof, and is not used in any way as a deck; at the front part of it is the wheel house, a small box for the steersman, and above all rises the gigantic beam of the engine, which is thus placed to occupy as little as possible of the valuable space below. The construction of these boats must strike every one who has seen them as extremely clever, the hull is made of the lightest possible materials, and is stiffened and enabled to bear the weight of its machinery without hogging by two great wooden trusses, somewhat resembling queen post roof trusses, reaching nearly from end to end of the ship, and above the upper deck; and this principle of suspension is further carried out by having six or more stout masts or poles from which iron tension rods diverge to different parts of the framing of the vessel; the fuel burnt by these steamers is wood, the draught of the fires is increased by fans worked by a donkey engine; the pressure is about 30 lbs. to the square inch, and the speed realised as much as 20 to 22 miles an hour. It should be remembered that these boats being under admirable legislation, and employing steam at no greater a pressure than 30 lbs., are not to be confounded with the Missisippi boats, which being apparently subject to no laws for the safety of life, and working up to a pressure of 140 lbs. on the inch, are the constant subjects of accidents of the most fearful kind.

Danube steamer.

In the same category as the Hudson steamers may be placed those employed on the Danube, a beautifully constructed model of one of which occupied a prominent position in the nave of the Exhibition, it is called the Frantz Joseph, and is the property of the Danube Steam Company; her dimensions fall far short of the Transatlantic steamers, being 250 feet in length by 30 broad, and with a depth of four feet; these steamers are built of iron, the engines of the one in question are oscillating, of 240 horse-power by Messrs. Rennie, she will carry 60 tons cargo, and makes the distance from Vienna to Galatz, upwards of 1,000 miles, in four days, returning against the stream in seven, which gives a speed of 10 miles with and 6 against the current, a speed far below that of the American boats.

Rhone steamer.

Among the French machinery in the Annexe, a drawing of one of the steamboats employed in the Rhone navigation

was exhibited by M. Schneider, of Creusot, in which, as far as could be judged by the drawing, the ratio of the length to the breadth appears greater than in either the American or Danubian river steamers, the length being about 250 feet, and the breadth only 16 feet, with a horse-power of 500. The speed of these vessels is said to be very great, but the exact rate is not mentioned.

Thames steamers.

England does not send any models or designs of vessels for fluvial navigation, her geographical position making ocean navigation the dominant branch of the science in this country, the almost only river boats being small steamers that ply on the Thames, in which there is not much to boast of either for ingenuity or beauty, they being rather seagoing steamers reduced in size than belonging to a distinct genus of vessel adapted to their peculiar requirements as in the case of the American above-mentioned; as an instance of this, it may be noticed that the cabin of a sea-going steamer is retained in these boats, although in their case utterly useless, by which means the deck load of passengers is so elevated as to render the vessel dangerous in case of a crowd; and, secondly, for this, the actual carrying part of the vessel, no shelter of any kind is provided, either from sun or rain, although so desirable in our changeable climate, and this for no other reason that can be thought of than because a roof would not be a proper appendage to a sea-going steamer. Whereas there is little doubt that were the useless and rarely visited cabins done away with, the deck lowered some three feet, and a light galvanised iron or wooden roof or awning thrown over the whole vessel, they would be increased in popularity, particularly in bad weather; they would no longer be the subjects of vexatious legislative interference on the subject of overcrowding, and the cost would be in no way increased. In all, even the smallest American river and ferry steamers, the boilers and furnaces are placed on the sponsons and the beam of the engine aloft, and this might also be adopted with advantage in our river boats, as it has the merit of keeping the body of the boat clear for passengers, permits of the deck being lowered from stem to stern, and keeps the varying weight in the centre, the only weight placed beyond the body of the vessel being balancing and constant ones; indeed, in some of the Hudson ferry boats the boiler is on one sponson and the engine on the other, thus keeping the boat herself entirely clear of machinery.

A model of a small steamer is shown among the French naval models, which is also intended for river navigation;

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she has been built for the purpose of completing the railway communication across the Rhine at Hombert, and is so constructed as to carry a whole train across on rails laid on the deck; no particulars are given, however, of her size, power, or performance.

Emperor's yachts.

In the garden behind the Palais de l'Industrie were two small yachts, said to be intended for the Emperor, but whether ordered by him or sent with a hope of His Majesty purchasing them did not appear; one was a screw steamer of from 25 to 30 tons, built by Guibert of Nantes, with wooden planking over light angle iron timbers; her engines and boilers are right aft, and the centre is thereby left clear for the saloon or cabin; she is rigged as a fore-and-aft schooner, her masts can be lowered in the partners to pass under the bridges on the Seine, and she has no funnel, the mainmast being hollow and made to carry off the products of combustion. Alongside is a small sailing yacht of very light draught of water, and with an iron sliding keel in the form of a fan, she is also fitted with air-tight lockers all round, so as to render her sufficiently buoyant to support those on board in case of accident.

This may be said to conclude the collection of models relating to inland navigation, for of the other subdivision of this part of the subject, namely, boats suited for canal navigation, there is absolutely no representative in the Exhibition, to be accounted for, probably, by this mode of communication having been to such a great extent superseded by that of railway, that it has lost, in a great measure, its interest with the public, and also with inventors and improvers.

I have the honour, &c.

Francis Fowke,

Captain, Royal Engineers.

On Ceramic Manufactures.—By M. Léon Arnoux.

To the Right Hon. Lord Stanley of Alderley, President of the Board of Trade, &c. &c.

My Lord,

Knowing the important place which Ceramic Manufactures held in the Exhibition of 1851, the impulse which had been given to them, and the reputation which some of the British productions then obtained, the Exhibition in Paris, where all nations had agreed to meet, was a great attraction to all interested in this subject.

The interval between these two events was only four years, a period relatively very limited for giving stability to the progress already achieved and for making it known: still, with a substance which lends itself to the modifications of form and colour so easily as the basis of pottery, the amateur and the artist would always be able to find a field for the most interesting investigations. Thanks to the efforts made on every side, and to the ready response given to the invitation of the Emperor of the French, the artist and the workman have both been equally gratified.

Special efforts made for an Exhibition.

We have some experience, however, of what takes place in these Exhibitions, and never give full vent to our admiration. With the desire of obtaining the favourable judgment of the multitude, second as well as first class manufacturers easily succeed in misleading public opinion, by getting up their productions in a clever manner; some try to attract attention by exaggerating the dimensions of an article which is usually made of a smaller size; others, with more intelligence, endeavour to conceal the real nature of a coarse material under an original or pleasing form. Some I know, who practise a deception by the display of products ornamented or manufactured by other hands than their own; in short, there are others, and they are the most numerous, who, on such an occasion, think it fair to deviate from their usual custom, and to call for the temporary services of an eminent artist. This year especially, far more than in preceding Exhibitions, every one understood so fully how great was the importance of the trial in which he was going to take a part, that on all sides were to be found, to some extent, signs of these special efforts which do not fairly represent a manufacture reduced to its normal condition; but it is well to notice them, because even an isolated effort

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almost invariably leaves behind it in the garden of industry some stray root, which, after having derived nourishment and strength unobserved, may at a later period produce a vigorous tree. It is, therefore, only by a conscientious examination of the *ensemble* and of the details, that a true opinion can be formed on a branch of industry which presents itself in so many different aspects, and the progress verified by seeing it conspicuously shown in the greater number of an exhibitor's works.

The quality of the materials used may then be compared with that of those already known, and an opinion formed of the ability with which the manufacturer has made use of the resources which art places at his disposal. Then would be the moment to discover whether, among the vast number of productions, there be not one which, however small, might not be considered as the budding promise of a new variety of ceramic art.

Art inseparable from industry.

Ceramic manufactures may be considered from two different points of view, an industrial and an artistic; but neither can ever completely sever itself from the other. The experience of the past teaches us that however skilfully the potter may combine the materials with which nature provides him, it is only the possession of real artistic talent that will ensure his reputation. Putting aside all the examples furnished by earlier ages, we may quote Luca della Robbia, Palissy, and Wedgwood, as types which united in themselves a happy combination of these qualities.

A detailed examination of the different branches of the art which forms the subject of this report will enable us to consider the intrinsic qualities for which each is remarkable. There is an action at work, assuming every day a more decided character, which is inciting the manufacturer to give more correct forms to the materials with which he works, and to seek the aid of artists of real talent, who until now have been unable to make industrial art their study, because the public has been content with rude imitations of the masterpieces formerly produced. The favour which has been recently shown to the potter's art, and which has induced many persons to make it their study, has had much to do with bringing about this result. Twenty years ago the question of art was not mooted beyond the walls of the Royal Manufactories, and artists of a very inferior class only were employed in private establishments. Now, on the contrary, thanks to the impulse given by the Exhibition of 1851, artists of the highest order, and especially sculptors, are co-operating with the manufacturers, who are thus enabled to produce very perfect specimens.

This beneficial assistance which art and industry render to one another is now too well established not to endure; we have only one thing left to desire, and that is that painting should take a more active part in all future improvements. We have always found painters, sculptors, and architects ready to second the step made in advance, because they all understand how important a part is reserved for ceramic art in general decoration. They only want, in general, to be summarily initiated in the processes of the manufacture, and in the requirements of the material employed. With this view, a course of lectures on Ceramic art in the metropolis would, perhaps, remove all difficulties from the path which they seem so anxious to follow.

Great seats of ceramic manufacture.

The productions of the XVIIIth Class occupied a large space in the Universal Exhibition, on account of the number as well as the variety of the specimens shown. This is the more remarkable, as it is only within the last sixty years that Ceramic art, as applied to industry, has developed itself to any great extent, and as yet only half of this prolific century has passed away. There are at this present time only three countries of which we were able to make a minute examination, where pottery is produced as a branch of industry. England is well known to be the seat of the largest manufacture, France follows closely at her heels, while Germany, once far in advance of both, with the productions of Dresden and Berlin, is now lagging considerably in the rear. With the exception of China, which is too distant to have any influence upon our markets, and whose productions, besides, are declining in importance, no other portions of the globe offer more than the merest indications of a manufacture which, from the inferiority of the specimens shown, cannot hope for a future. It was therefore for England and France to contend for the prize of excellence,—France armed with the Manufactory of Sèvres and her fancy porcelain, England with her earthenware, her Parian, her *porcelaine tendre*, her paving tiles, and the results of the experiments which she has undertaken with so much spirit. In short, on one side was to be found an intimate knowledge of form and ornament, and on the other, a correct appreciation of the real wants of the masses, and an artistic feeling in rapid development.

It was impossible that the struggle should be otherwise than animated; and if, after examination, the Jury awarded equal praise to both countries, their favourable judgment is due to a small body of our manufacturers, who, with Mr. Minton at their head, spared no exertions steadily to hold up on high the industrial flag of Great Britain.

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Terra cotta.

As regards Terra Cotta, the most unpretending branch of the art of pottery, although so useful whenever there is a a lack of building stone, the largest contributions were from the continent. But we can hardly give the name of Terra Cotta to the compositions of M. Graillon, of Dieppe, who has thrown the charm of truthfulness into his groups of beggars and sailors. The substance used has, in this instance, only served to interpret the idea of the artist, and is of no intrinsic value. Materials admirably adapted for interior and exterior decoration are to be found in the altars and fountains in artificial stone by M. de Bay, of Paris, in the vases and statues of Messrs. Feilner and Co., of Berlin, and in the beautiful Romanesque portico of Messrs. Virebent Brothers, of Toulouse.

Messrs. Villeroi and Bock are less happy with their immense flower-stand, the material of which seems too coarse to play so important a part in the interior decoration of our habitations. For this purpose the vases of Mr. Follet, on account of their good taste and moderate dimensions, are more appropriate. All these specimens exhibit evidence of the most careful execution, an essential condition in this class of productions; the forms adopted also prove that they have been selected from the best sources.

Mosaics, &c.

If England contributed no specimens of Terra Cotta, she could proudly display her Mosaics and Encaustic Tiles, which have already been used in the decoration of several of our public buildings, and which are becoming daily more popular. On the continent the attempts to produce these pavements have not been very successful.

In the Exhibition were to be found the imitation mosaics and the enamelled tiles in the Moresque style, with which Messrs. Minton & Co. have so well seconded Mr. Owen Jones in his reproduction of the Alhambra at Sydenham. The superiority of these tiles, due to the durability of the material, the precision of the mechanical process, and the good taste of the designs, is so universally acknowledged that it is unnecessary to make any further mention of them.

Stoneware.

Stoneware, which was revived with so much *éclat* some years ago by M. Ziegler, has degenerated to such an extent, since that eminent artist let the manufacture fall into ignorant hands, that it hardly obtained any attention. The sober colour of this substance is, however, well calculated to produce good effects; as a proof of which may be mentioned the estimation in which we hold Flemish ware, as well as, notwithstanding its coarseness, that made in England in the time of the Tudors.

On the other hand, the ware with opaque enamel, commonly called Majolica, the production of which had ceased in consequence of the negligent manner in which the manufacture was carried on, awoke up to new life in the Exhibition of 1851, and was further developed in that of 1855. This revival was too warmly greeted for the work to be again discontinued; and Messrs. Minton & Co., and M. Giovanni Freppa, of Florence, deserve all the credit of the undertaking.

Majolica.

Putting aside porcelain, there was no pottery in the Exhibition, which could compare with this Majolica, as regards originality of design, as well as good effect. Although the process of this manufacture is well known, partaking as it does of the nature of those of the Arabians, of Bernard Palissy, and of Luca della Robbia, it required a careful combination of those processes, on the part of Mr. Minton, to produce the vases which surprised the public all the more, because it was quite unprepared for the sight. The coarse quality of the material used has, at least, the advantage of lending itself to the caprice of the artist, and its inferiority disappears under the coating of transparent or opaque enamel, the colours of which can be modified in tone, to the extent that may be required in order to obtain perfect harmony.

This style, as lately produced, requires the combination of the talent of the enameller, with that of the ordinary potter. One only fault could be found with the specimens, and that was, that they were, in general, of too decided a colour, while any man of taste would have preferred tones of a more sober hue, and a less perfect glazing. But we must here make allowance for the demands of the market, and, considering the progress made in this respect since the Exhibition of 1851, we may safely expect that the cause of this objection will soon cease to exist.

Messrs. Minton and Co.

In a series of large works is to be observed the care with which Mr. Minton has designed his models, and the efforts he is making to give to modern productions that stamp of originality which once belonged solely to ancient art. Among the most remarkable, we would mention a cistern with a blue ground, supported by Cupids; a large ewer and dish for ornamental purposes, richer than most of those which we derive from the period of the Renaissance; a wine cooler with handles representing satyrs, which by the beauty of its enamelling was worthy to be compared with the finest porcelain; and, lastly, a second large cistern modelled by Baron Marochetti. Most of these specimens deserve to rank as *chef-d'œuvres* of sculpture applied to industry, and do much honour to M. Jeannest, to whom the execution of them had been entrusted.

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Another series of works, in which the same manufacturer has more especially devoted his exertions to reproduce the specimens of the Italian school of the 16th century, show that ancient art possessed no secrets which he has not discovered. We may mention his Italian vase with a white ground, ornamented with grotesque figures; and a set of large dishes, of which the most remarkable was that after Baptista Franco, a work which is now in the possession of Her Majesty.

In order to excel in this style, for which he possesses an enamel admirably suited to the adaptation of the colours, Mr. Minton is only in want of artists, who, by greater practice in this kind of painting, shall have acquired great facility of execution, which is a condition essentially necessary for their perfect success. Accustomed as we are to see the old Italian Majolicas, the painting on which resembles rather the expression of the most unaffected ideas than a studied work, a Majolica produced with too much care loses the greater part of its charm. In these productions Mr. Minton had but

M. Freppa.

one important competitor, a native of Italy, the country which has had the double glory of having been the seat of the Etruscan manufacture, and, 2,000 years later, of presenting to the world these beautiful majolicas. This rival was M. Giovanni Freppa, of Florence, who is intimately acquainted with the trade in works of art, which he has long carried on, and who, having had the good fortune to study the famous manuscript of Picolo Passo, is conversant with all that is known on the subject of the Italian manufactures as transmitted to us by Passeri, Massa, and Fontanari. He made his experiments at Doccia, near Florence, in the manufactory of the Marquis of Ginori, and it took him no less than six years to produce, with the co-operation of a skilful chemist, such Majolicas as he exhibited.

Thanks to the cheapness of labour, and the proverbial facility of becoming familiar with the fine arts in that country, M. Freppa has been able to produce, at a low price, works which are highly prized in the best collections. Among his finest specimens we prefer his egg-shaped vases, ornamented with paintings after the frescoes of André del Sarto, the bowl with three lobes, within which is represented the Judgment of Paris, being after Julio Romano. There is, however, one objection which we could make to M. Freppa, and that is, that in seeking strictly to reproduce the ancient majolica, he has exaggerated rather than modified the faults of his models, which tends to give a hard appearance to his productions. But M. Freppa is one of that band of potters who cultivate the ceramic art on account of the pleasure which they derive

from the study, and in such hands we can only expect progressive improvements. M. Devers, of Paris, who is known as a skilful enameller upon lava and metal, exerted himself to produce some large works in the style of Luca della Robbia: only one fault could be found with his great picture for mural decoration, namely, the disagreeable effect produced by the lines where the plates are necessarily joined in order to connect the subject. If M. Devers had, on the contrary, confined his plates to the exterior circumference of his figures, and filled his centre with a small mosaic, this objection would not have occurred, and at the same time the effect of the figures would have been improved.

Nevers Faïence.

Before leaving this part of the subject, we must allude to the attempts made by M. Ristori, to rescue the Faïence of Nevers from the oblivion to which it had been consigned. M. Ristori is an able artist, educated at the French academy at Rome, and deserves praise for having devoted much time to the painting of the beautiful plates which he exhibited. He has treated them in the style peculiar to the beginning of the 17th century, and has had the good sense to use a sober blue, which, relieved by a few touches of yellow, produces a very pleasing effect. With refined outlines, and firm and compact colouring, M. Ristori's plates are rather works of art than marketable objects, and vastly superior to any Nevers Faïence we have seen.

Palissy ware.

One of the characteristic features of the Exhibition was the number of attempts to produce picturesque specimens of pottery by means of glazes coloured in the mass. The solution of the problem of colouring reliefs is so difficult, that it is not surprising that with limited resources these attempts should not all have been successful. But the start has been made, and it is probable that this art will soon be greatly developed. The expression of this hope is not meant to imply that we wish to revive the manufacture of articles which cannot be used, such as Palissy's dishes covered with reptiles; but that by recovering the technical means, it may be possible to give to articles of daily use a picturesque form, and great harmony of colour. In order to preserve their character, the potter must apply himself, not so much to the exact reproduction of the animate and inanimate objects which nature furnishes, (a course which would be satisfactory to the naturalist only,) as to their selection and mode of grouping, so as to obtain the happiest contrast of form and colour.

These experiments have been chiefly carried on near Paris, and England would have remained unrepresented among the eight or ten exhibitors from that neighbourhood, had not

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Mr. Minton contributed a considerable number of pieces in this style. The French exhibitor who approached nearest to the immortal master of the art was M. Avisseau, of Tours, whose dishes covered with reptiles were very successful. And yet, is not this servile reproduction a mistake on the part of the manufacturer? When the greatest part of one's life has been spent in the study of these ingenious processes, it seems but reasonable to make use of them in order to establish one's own individuality. The exhibitors of Paris were only anxious to produce effects with their coloured glazes, and with the accidental blending of the colours as they ran one into the other. As their pallet is but poorly supplied, these specimens had a monotonous appearance, and so carelessly had the models been selected, that at most they were only fit for cottage decoration. We must, however, in justice to M. Barbiset, of Paris, raise him a step above the greater number of his colleagues.

None of the specimens above mentioned, however, could serve as the basis of a manufacture sufficiently large to become an extensive branch of commerce. A moment's consideration of the subject would lead us to point to earthenware as the kind of pottery which is actually produced in larger quantities than all others, and it is in Great Britain that the most important seat of this manufacture is to be found.

Earthenware and porcelain.

England was represented in Paris by twenty-three exhibitors of earthenware and porcelain, among whom the names of Wedgwood, Minton, Copeland, Ridgway, Mayer, &c., are familiar to the public. The display they made was, as a whole, such as to be long remembered by our allies, who have been for so many years accustomed to the brittleness, the small dimensions, and the neglected ornamentation of their own earthenware, that they were perfectly charmed with our specimens of stronger substance and larger size, and with the good taste of our printing and enamelling.

High duties and prohibitions.

The public was by no means surprised that the manufacturer was obliged to demand such a price as would remunerate him for the efforts he had made to attain excellence of quality and perfect finish, and that this price should be considerably larger than that of the French earthenware. The British exhibitors received, in consequence, many pressing orders, which, however, in the present state of the laws which regulate the French Customs, they were necessarily obliged to decline. We regret to have to say, with reference to this matter, that the alterations of the tariff, which have been talked about since 1851, have not yet been realized, and that our Faïence is still absolutely prohibited. Perhaps an inquiry into this subject, undertaken simultaneously by both

Governments, would have the desirable result of determining whether the removal of this prohibition, or the levying of an amount of duty *ad valorem* would not prove more advantageous than the course now pursued. A greater interest attaches itself to the question of the modification of the tariff from the fact that it has never been properly studied in France; and even when the French Government instituted an inquiry into the subject in 1835, they were absolutely destitute of information with regard to what was taking place on this side of the channel. In opposition to the consequences with which the French manufactories were threatened by any such modifications, the treaty of 1786 was held up as a warning; but like many bugbears, it grew more alarming the further we moved away from it. This treaty had, in truth, but an ephemeral existence, and did not affect either the pipeclay or the porcelain manufactures, for the very simple reason that neither of them had, at that time, been established. Possibly it might have injured the manufactories of that common kind of pottery known by the name of *Delft*, which alone were then in existence; but did the almost immediate suppression of the treaty prevent their disappearing one after another? Assuredly not; for after having outlived the treaty, these establishments ceased to exist, in consequence of the inferior quality of their productions: and a similar fate awaits any manufacture which does not keep pace with the progress of civilization. The French pipeclay manufactures, which supplanted those which we have just mentioned, will in their turn have to give way to hard porcelain, whether the tariff be altered or not.

Their effect on the production of earthenware in France.

It would be easy to show that the absolute prohibition which was imposed with the view of protecting and developing the French earthenware manufacture has been fatal, rather than favourable, to its production. In fact, although the prohibition appears to afford protection to extensive interests, it only serves as a buckler to a very small number of manufactories. In the inquiry made in 1835, it appears that ten houses were mentioned, of which only half could be considered of any importance, from the amount of their capital or the number of their workmen.

In the Exhibition of 1855, only five of these manufactories were represented, namely, those of Creil and Montereau, of Sarreguemines, of Bordeaux, of Gien, and of Grigny. The others did not think fit to send specimens of their products, and we know that within the last twenty years no manufactory of any importance has been established. The exportation of earthenware from France, notwithstanding the notable increase of her mercantile navy, is quite insignificant. Are

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we to conclude from this that the French potteries will have no future? It will be sufficient to state in reply, that at the very time that the manufactories of earthenware were being established, the originators of the hard porclain were making their first experiments, and that they have met with such success that they now have no less than 122 ovens in 80 manufactories, with an annual production of 1,000,000*l.*, giving occupation to 15,000 or 16,000 workmen, and employing a capital of 1,100,000*l.* Such is the way that a branch of industry developes itself when once it takes root in the land.

As early as the year 1835, the French porcelain makers declared that they regarded the modifications which might be made in the customs' tariff with indifference, and, as a proof that they were in earnest, they went to the United States, and even came to England, to pit their productions against those of our own land.

On the contrary, the French manufacturers of earthenware are only able to use clays of an inferior quality, which, besides, are not to be found in any large quantities; and in addition to this, the low price of common articles in porcelain has very much reduced the number of objects to be produced.

To any one who, like myself, has examined all the late French Exhibitions, and especially that of 1844, it is evident that the earthenware of the present day is inferior, rather than equal to the manufacture of that time.

The Exhibition will have contributed in no slight degree to disperse the darkness which appears to those who are interested in the matter, to have been intentionally made to envelop it.

Erroneous impressions entertained.

Generally speaking, the most false ideas were entertained on one side of the Channel respecting what took place on the other. Thus, many of our manufacturers believed that their productions were cheaper than those of the French, and that if the prohibitory law were removed a great outlet would be made for our cream-colour ware, and that the good old days of the willow pattern would return. In like manner an opinion prevailed in France that English pottery could be sold at such fabulously low prices that its cheapness alone would cause it to be greatly sought after. The truth, however, lay neither on this side nor on that. The time when *inferior* earthenware could be sold in France has long passed away, and articles of equal quality are as cheap there as in England. At the present day there is only room for the introduction of beautiful specimens of Faïence carefully printed and enamelled: of this ware there was only to be found among the French contributions, one bad imitation, and that was sent from the manufactory at Montereau.

The French are not yet aware that in consequence of the rise in the price of all our raw materials, of coal, and of wages in general, the market value of our productions has increased in a considerable degree, and that while in France wages and prices have been much reduced, in England the reverse has been the case. How has it then happened that, under circumstances so favourable to the export of French productions, these manufactures have not been developed, when in England the amount of business done has been so sensibly augmented? It is because British manufacturers do not relax their efforts to improve their productions, although they have to sustain an unlimited amount of competition, which doubtless acts as a great stimulus; and because, as was stated twenty years ago by Mr. Clement-Desormes, "the same process which ruins one manufacturer enriches another who is more careful in the employment of it."

In order to establish the superiority of the British earthenware, we have only to mention one more fact, which forcibly depicts the real state of the case. Not one of the visitors who were disappointed of being able to purchase these beautiful works, thought fit to transfer his orders to a French manufacturer. The prohibitory laws are therefore profitable to none; and, judging by facts after the experience of half a century, they are powerless to assist those whose interests it is their mission to protect.

Duties charged in other countries.

With a view to obtain an exact appreciation of the importance of the Customs' dues on such heavy goods as earthenware, we have but to examine into what takes place in Belgium, Prussia, and Austria, which admit British productions on the payment of the duty. In Belgium, where the duty on our printed earthenware seems moderate, being only 25 francs on 100 kilogrammes, a dozen plates are charged with 1*s.* 8*d.*, and in Prussia, where the rate is 20 thalers on the same weight, the duty is no less than 4*s.*, or 100 per cent. on the value. British porcelain, which is lighter, but which is charged higher, pays a duty of no less than 5*s.* in Belgium, 11*s.* 3*d.* in Prussia, and 12*s.* 5*d.* in Austria. These figures, which all apply to a dozen plates, are very significant, and deserve to find a place here, in order to show what obstacles are opposed to the introduction of our productions on the continent.

Consequences.

That it is desirable to modify the greater number of these tariffs is proved by the experience of the last two years, which shows that the prosperity of the trade depends too exclusively on the state of the American market, which alone, in ordinary times, absorbs *half* the exports. The financial crises which have been of late so frequent in the

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United States, have given a heavy blow to a great number of our manufactories.

After the United States, the countries which import the largest quantities of our productions are those which are the farthest from us; and, by a strange anomaly, the states which are nearest to our own shores, those with which it is especially our interest to increase our commerce, are the very ones which close their doors to us with most obstinacy. The whole of the European states hardly receive altogether the fifth part of our exports.

Production in Great Britain.

In spite of all these circumstances, so unfavourable to the free exportation of British earthenware, the power of production is so great that our exports have been almost tripled within the last 15 years. Their value, which in 1840 was 573,000*l.*, rose to 1,122,000*l.* in 1851, and to 1,338,000 in 1853;* showing an increase of 216,000*l.* in two years. It is true that the value of the exports shows a decrease in 1854, and has even diminished to 1,019,000*l.* in 1855; but the crisis in the United States, and the war, suffice to account for the change. The actual production under normal circumstances, however, cannot be valued at less than 2,500,000*l.* If it be considered that this branch of industry finds in its own soil immense quantities of all the raw materials which it requires, and that it is thus preserved from catastrophes which may occur to such of our manufactures as depend on foreign nations for a supply of materials, it must be acknowledged that it would be sound policy to encourage so valuable a source of national wealth by creating further outlets for its exportation.

Production on the continent.

Although the manufactories of earthenware are numerous on the continent, there appears to be only one great centre of production out of France which is deserving of notice. I allude to the group of manufactories at Luxembourg, in Holland; at Keramis, in Belgium; at Vaudrevange, at Manheim, and Metlach, in Prussia; and at Sarreguemines, on the French frontier. These establishments, which have united their interests so as to form a sort of *joint stock company*, under the names of Villeroi and Boch, and of Boch Brothers, have obtained possession of almost all the German markets, a task rendered easy by their topographical position, which is most favourable for the exportation of their products. To compete with them, the duties only permit the importation of the least deserving of British productions, namely, the cream-colour ware, such as was manufactured 80 years ago; and which is only admitted because, from being lighter, it

* The number of pieces exported in 1853, amounted to 100,000,000.

has less duty to pay. All who are well acquainted with the trade know that British earthenware would be preferred on account of its strength, which is much greater than that of the manufactures of which we have just been speaking.

Biscuit porcelain.

The biscuit porcelain, which has been used for statuettes, has for the last few years been in very great request. In England we have the Parian, which is daily getting more popular, notwithstanding its high price. In consequence of the initiative taken by M. Gilles, a skilful manufacturer of Paris, France exhibited a large quantity of white and coloured biscuit. Works of a large size have been produced by this manufacturer, and among others a stag and a reclining figure, which, as manufactures, had unquestionable merit, and had been cast from good models. Messrs. Dubois and Jouhannaud have made great efforts to leave the old track into which the majority of the Limoges manufacturers appear every day to desire to penetrate further. With the aid of M. Constant, one of the most skilful of French modellers, and now foreman at M. Barbedienne's establishment, they exhibited as the most remarkable portion of their contributions, a large ewer, in the Louis Quatorze style, which recalled to mind similar works engraved by Lepautre. This work was very successful, although a rather more careful execution would have been desirable. The German manufacturers sent, as they did in 1851, a large number of statuettes, but there was the same cold and bluish tone about them, and the same appearance of hardness to which we have several times alluded. The usual objection to all these biscuit figures is, that on leaving the mould they are not mounted and repaired by sufficiently clever workmen; and that, in addition to the lines where the different parts are joined remaining visible, the features and extremities are almost always retouched in a lamentable manner. Such as they are, there is an immense distance between these biscuits of hard porcelain and those which were manufactured at Sèvres, from 1770 to 1790, and which, instead of having a blue tint, were of a beautiful milk white; while, in consideration of their perfect execution, the want of transparency of the material was overlooked.

We do not hesitate to say that in the production of statuettes in biscuit, British manufacturers leave all their competitors far behind. This manufacture, which had been attended with so many advantages with regard to the progress of art in the Potteries, was highly appreciated at Paris, and created much envy among our foreign competitors.

Messrs. Minton and Copeland stand at the head of the producers of this style of work, which they have originated; and the improvements they have effected, as respects execu-

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tion, dimension, and the beauty of the models, have surpassed the most sanguine expectations.

The finest specimen of biscuit in the Palais de l'Industrie seems to me to have been the bust of the Empress, which was modelled by the Count de Nieuwerkerke, and executed at Messrs. Minton's establishment; and the superiority of the material which we use over that employed in France was clearly shown by the comparison of the two large busts of the Emperor, one of which was produced by Messrs. Minton and the other by M. Gilles. It is satisfactory to observe that in their works in Parian, our manufacturers no longer confine themselves to reproductions from the antique, or to well-known pieces of sculpture, but on the contrary choose original subjects for their works. From among a vast number we would select for special mention Mr. Copeland's group of Ino and Bacchus, after Foley, Mr. Minton's large wine cooler by Jeannest, his Highlanders, his group of Cain and Abel, and above all his charming statue of Lady Constance Grosvenor. As far as regards beauty of form and admirable execution, it seems difficult to make any further progress.

Jasper.

Mr. Wedgwood's contributions consisted chiefly of his vases with a blue ground, ornamented with white reliefs, better known under the name of Jasper. It is always a source of pleasure to amateurs to see these beautiful works produced by the co-operation of two such men as Wedgwood and Flaxman. Mr. Wedgwood maintains his position at the head of this industry, and is celebrated for precision and clearness in what is commonly called *potting*. He has preserved all the good traditions, but we should be glad to see so celebrated a manufacturer impressed with the truth of the old adage "*Noblesse oblige*," and attempt the production of new kinds of pottery.

Royal Manufactory of Saxony.

The Royal Manufactory of Saxony, which had been the birthplace of the hard porcelain at the beginning of the eighteenth century, and which had been always so highly esteemed on account of the beauty of its productions, did not think proper to send any contributions to the Exhibition of 1855. We are unwilling to draw an unfavourable inference from this fact, but we would recommend amateurs to value more than ever the specimens of the old manufacture, for it is much to be feared that, deprived of the royal grant, this establishment will never be able to regain the level which it once attained.

Royal Manufactory of Berlin.

The Royal Manufactory of Berlin, whose star was not quite so brilliant, has better sustained its reputation; it may be said that it has made a sensible progress since 1851. The display it made in Paris would even

be quite satisfactory if the want of a little more freedom and spirit were not felt in its paintings. This cold lifelessness, which for centuries has been one of the characteristics of German art, must not prevent our doing justice to the taste which has been displayed in the ornamentation of the large vases, and to the pureness of their design.

Hard porcelain.

It is in France, as we have already said, that is to be found the largest number of manufactories of hard porcelain, which have become so thoroughly acclimatized that the German producers now copy the French forms and designs. A considerable number of exhibitors contributed to this section. The greater portion of the French manufactories are grouped around the Department of Haute Vienne, from whence they derive their raw material. The recent discovery of large quantities of kaolin in the Department of Allier, in close proximity to some coal fields, will increase the production, and will change the locality of the chief seat of this industry.

In doing full justice to the material used by the French and Germans, we must acknowledge that in articles of daily use, the question of form is completely sacrificed, and with two exceptions, it is only the manufacturers in the neighbourhood of Paris who know how to show the beauty of the material to advantage, by giving it an elegant shape. The greatest advance, as regards execution as well as beauty of material, was attained by M. J. Pouyat, of Limoges. This manufacturer, who possesses vast *quarries* of kaolin, and who is at the head of well-organized manufactories, has increased the whiteness and transparency of his porcelain, which resembles even if it does not surpass, that formerly produced by M. Nast, and which was regarded as the type of good porcelain. M. Alluaud, with quite as good materials, has too much neglected the question of form, to obtain for his porcelain the attention it deserved.

That which most contributed to the success of the manufacture of hard porcelain at Paris was its falling into the hands of such skilful decorators as Messrs. Boyer, Lahoche, Jacober, Rihouet Lerozey, and others, who purchase their white porcelain from the Paris warehouses, and cover them with great taste, either with rich or light ornament. In England there exists no such special branch of industry, a circumstance which is most favourable to French manufacturers. As respects most of the porcelain which is to be found in the market, the style in which it is ornamented is very inferior, the effect being produced by the violent contrast of the colours. The cause of this, it is said, is the marvellously cheap rate at which these works are produced. For this

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same reason a new style of gilding came into vogue, somewhat similar to that employed at Meissen, and which consists in the use of gold in such a state of thinness that a very small quantity is sufficient to cover a surface relatively very large. This gold has great brilliancy, but we believe it to be of doubtful durability, and if there is anything at which we ought to rejoice, it is that although English manufacturers had many opportunities of purchasing this process, they wisely rejected that which could only be an encouragement to bad taste.

Competition.

The spirit of competition, much developed at the present time, which prompts so many French and German manufacturers to secure a market for their goods by means of successive abatements of the selling price, does not seem very promising for the future. There are, in fact, two very opposite modes of entering into competition. The one consists of living for the present and sacrificing the future, the principle of which is the reduction of the price, a course which infallibly leads to doubtful profits and low wages, and may be the source of serious political difficulties; the other is based upon the improvement of the quality, which is the true mode of establishing a good reputation, and securing for the future a more stable patronage, thereby contributing as much to the welfare of the manufacturer as to that of the workman. It is true that the continental manufactories, having but few outlets for their productions, and existing by their local consumption, have been to some extent compelled to seek after cheapness; but it is time that they should halt in the course they have adopted, if they would avoid the serious consequences which must befall them if they continue to persist in the system.

It is therefore quite expedient that to counteract this tendency, there should be an establishment, such as that at Sèvres, devoted to the manufacture of the finest kinds of porcelain, and having for its mission the maintenance of its productions in the highest regions of art. The eager admiration of all visitors bore testimony to the incontestable influence which this manufactory has exercised over the public taste.

Imperial Manufactory of Sèvres.

The Imperial Manufactory of Sèvres has not confined its productions to works in hard and soft porcelain, which have until now been sufficient to establish its reputation; enamels on metal are being produced there in considerable numbers, and specimens of Terra Cotta and Faïence are held up as examples of what can be done with these materials. In order to render the manufactory independent of the aid of any

branch of industry carried on beyond its walls, bronze works have been established for the mounting and decoration of large pieces of porcelain. In this addition to the manufactory, we recognise that untiring spirit of intelligent investigation which leaves so little repose to the learned director, M. Regnault. Seeing that progress might be made everywhere, M. Regnault has sought to realize improvements on all sides at once, and the variety and excellence of his contributions show that he has almost invariably been successful. We must also add that with the liberal support of the civil list of the Emperor, and the interest which the Minister of State takes in the manufactory, M. Regnault has been able to avail himself of the experience of the skilful assistants who have been long attached to the establishment, and as regards the question of art, he has had the co-operation of such designers as Messrs. Dieterle and Jules Peyre; such sculptors as Messrs. Klagmann and J. Feucherie; such figure painters as Messrs. Gerome and Fragonard; such flower painters as Messrs. Schilt, Lablée, and Fontaine; such a landscape painter as Jules André; and such enamellers as Messrs. Apoil and Meyer.

Progress made.

It is since 1848 that the greatest progress has been made at Sèvres, and this is in a great measure due to the admission of the artists who have just been enumerated. They have applied to the porcelain a lighter, more elegant, and, in a word, more ornamental style of painting than that previously adopted, which consisted, for the most part, in the reproduction of known paintings, or gave too much importance to floral decoration. There is one fact worthy of remark, and most honourable is it to the French character, that all the artists and workmen of the Manufactory take the greatest interest in the success of their productions, and quite unselfish does this interest appear to be, when it is considered that the remuneration which they receive generally falls short of that to which their talent entitles them; but they think it sufficient compensation to receive credit for having contributed to the completion of these works of art.

Although we are warm admirers of the Sèvres manufactures, we do not go so far as to approve unreservedly of everything that has been produced. In the first place, as regards the ormoulu mountings, admitting the beauty of the sculpture and carving, the metal generally holds too prominent a place; this is the opinion of those who acknowledge that it is necessary, and much more is it that of those who think, and perhaps with good reason, that it would be far better not to

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employ metal at all. In some of the forms, too much pretension to originality has led to a result of which the taste is questionable. Take, as an example, the vases illustrating the four seasons, in which a long neck, conical in form, fits badly on to the body of the vase. By way of compensation, the painting on these vases may be counted among the best for its lightness and good taste. In the great vase made in commemoration of the London Exhibition, and which was offered to Her Majesty by the Emperor of the French, the way in which the body is fixed to the stand appears open to objection. The bronze transversal ornaments, representing crowns of laurel, are too large, and besides, the vase being in biscuit, and covered with paintings of a very dull hue, leaves the public in doubt as to the quality of the material used.

Celadon green vases.

Sèvres seems chiefly to excel in its vases of celadon green. The idea was taken from the Chinese celadon green vases, ordinarily covered with coarse and grotesque reliefs. Between these vases and those exhibited by the Sèvres manufactory, there is so great a distance that it is hardly possible to remember their origin. The *pâte* used for the reliefs is perfectly white, and the artist has exhibited much skill in the mode in which he has availed himself of its transparency in the graduation of the lights. The finest of the celadon green vases was, perhaps, that which arrived the ast, designed à la Louis XVI., of which the frieze round the middle left white, was painted in *chiaro' scuro* in purple. A band of children dancing in a circle are running round the vase, until they disappear into a vault which opens wide to receive them, and which is just indicated on the principal front. The tone of this frieze contrasts very happily with the celadon green hue which is the dominant colour of the whole work. Several other of these vases would, perhaps, have been improved by being thus partially relieved by a border of a more decided colour than the ground.

Revival of the *porcelaine tendre*.

The dark blue productions of Sèvres are too celebrated for it to be necessary to make any allusion to them here. A description of the 200 vases of different forms which were exhibited, would far exceed in length the limits of this report. But we cannot pass over in silence the success with which the production of *porcelaine tendre* has been resumed, a manufacture which, during the second half of the last century, shed such lustre upon the establishment. M. Ebelmen, before he died, had already commenced preparations for this revival; M. Regnault has accomplished them, and although certain portions of the work denote a little uncertainty in the processes, the victory is virtually won.

Sèvres has had the good sense to use its ancient moulds, the forms of which, though often fantastical, have much firmness and are very ornamental. The colour of the ground is not, perhaps, always as rich as that in the old specimens, and we saw some plates with a pink ground, in each of which the tone varied in intensity; but we are aware that these faults can only be overcome after long experience, and that it is only within the last four or five years that this manufacture has been resumed at Sèvres.

This leads us naturally to consider how the British *porcelaine tendre* figured at the Exhibition.

British *porcelaine tendre.*

Here was to be found the reverse of what occurs at Sèvres, namely, industry taking precedence of art, and we may say without fear of contradiction, that it is only in England that a wealthy man and a man of taste can obtain what is suitable for the use and adornment of his table. This manufacture has, therefore, become eminently British, and though a man would go to Sèvres to purchase a pair of artistically decorated vases, it is in England only that he could procure really beautiful dinner and tea services. In this respect, therefore, the trade belongs to us, and with the exception of the manufactory of M. De Bettignies at St. Amans-les-Eaux, whose productions, unless when entirely covered with paintings, are comparatively speaking of a coarse nature, we do not find any establishment on the continent which can be compared with those of Messrs. Copeland, Rose, or Minton. The workman knows full well that it is far more difficult to make plates and dishes of a uniform shape, than vases. This brings to my recollection the answer which M. Brongniart used to make to those porcelain manufacturers who boasted of the perfection of their productions, "send me a good oval dish," and many of them were in consequence unable to send anything at all.

Objection.

Certain very particular amateurs bring an objection against British porcelain, and say that as it has phosphate of lime for its basis, instead of being entirely composed of *pâte frittée*, it has no claim to be called *pâte tendre*. This objection appears to be nearly groundless. The chief beauty of the *pâte tendre* consists in the complete amalgamation of the colours with the glaze, and also in its capability of receiving certain tints which cannot be applied to any other kind of porcelain, such as turquoise blue, emerald green, and the *rose du Barry*. If our porcelain combines these qualities in the highest degree, if its whiteness and transparency have been increased by the employment of phosphate of lime, who has any reason to complain? Our productions possess all the advantages of the old porcelain, and have in addition several

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accessory ones; we shall, therefore, do wisely to uphold this manufacture, since it brings us nearer to perfection.

Messrs. Copeland and Rose. Mr. Minton.

Mr. Copeland and Mr. Rose, of Coalport, exhibited some very remarkable productions; the Worcester imitations of the enamels of Limoges, most beautifully executed, were much admired, while Mr. Minton distinguished himself by the great progress which he has made in this branch of manufacture. As Mr. Minton has obtained these magnificent results by his own unaided efforts, and at his own pecuniary risk, many persons do not hesitate to award as much credit to them as to the manufactures of Sèvres, which have required the co-operation of a large number of talented men, as well as of unlimited State funds. It was a piece of good fortune to Mr. Minton that both he and the Imperial Manufactory should exhibit at the same time vases of the old Sèvres design, because the advantage was, in some instances, on his side, as his coloured grounds are quite pure, and his gilding brilliant and substantial. What would not British exhibitors have done, had they received the aid of painters as skilful as those employed at Sèvres? As, however, the exhibitors in this line have made such progress, and are so eager to advance yet further, the absence of a manufactory in England carried on at the expense of the Crown need not be regretted. Sèvres admirably fulfils its mission, which is to produce works of art of the highest class, and in this respect it holds an exceptional position which cannot be attained by any of our manufacturers.

As for us, who have reached a culminating point in the scale of progress, it is unfitting that we should forsake the industrial element, in order to rush into the domain reserved exclusively for the fine arts. What concerns us is to take advantage of the resources which art places at our disposal, to form a special class of decorators or painters on porcelain, whose influence may happily be brought to bear upon our productions.

School for Artists.

The establishment of a good school for porcelain painting is not an easy task. To be a good artist, it is not sufficient to have acquired by long practice the knowledge of the technical processes; it is necessary to know how to compose, or, in other words, to make the subject selected subordinate to the form of the vase, and the accessories subordinate to the principal subject. He must find the means of realizing his ideal in the design of his composition, in the choice of colours, and in the proper balancing of the masses; and above all, he must have that lightness and firmness of touch without which it is impossible to obtain the approbation of the true connoisseur. It is the indispensable union of these

qualities which renders the good porcelain painter a *rara avis*, in the pursuit of which many of our manufacturers have already wearied themselves to no purpose.

If such a school cannot be immediately established, we have everything that is required to compass an improvement which, although more unpretending, is still very important. We should give to our workmen and artists such an education as would render them specially fit for the branch of industry which they follow, without obliging them to mount every step of the ladder which those who devote themselves entirely to the culture of the fine arts have to climb. The time which workmen are able to give, after their labours in the manufactory are over, to the cultivation of their intellectual faculties is too short for them not to be disheartened, when the advantages which they may derive therefrom can only be shown to them in a very remote future.

That which contributed more than anything else to establish the superiority of our predecessors in art work, was that each period had its style, and each workman his speciality, in which he made rapid improvements, without having the pretension, like the workmen of the present day, of knowing everything, or rather of copying everything. A perfect artistic education given to all, without the exercise of a proper discretion, would, besides, be objectionable, as it would deprive our manufacturers of their best workmen, who would be swallowed up in that already too numerous class of indigent artists. This complete artistic education should only be given to very select men, and in almost every case it is only in the metropolis that they can obtain the resources and the advice of which they are in want, in order that their progress be not checked.

Conclusion.

In conclusion, after having measured our strength with that of our competitors, we believe that, as regards commerce, we are at the head of the Ceramic Manufacture, that our title to the claim is grounded upon considerable mineralogical wealth, with an intelligent labouring population to work it, and that we may look with confidence to the future of an industry which has, in half a century, given birth to two such names as Minton and Wedgwood.

In comparing the Paris with the London Exhibition, we have pointed out a more marked progress as regards art than has taken place in any other class; that progress is due to the energetic efforts of our principal producers, to the very decided influence of our provincial Art schools, to that of our manufacture of Parian, and lastly to the favourable impulse given by the two Exhibitions. We have seen that

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as regards earthenware, Parian, and *porcelaine tendre*, to the manufacture of which the greatest amount of care has been given, we have no serious rivals, and if the Exhibition is to remain without result, and we are not permitted to send our productions to those who so frankly admired them, it will still be good policy to continue to improve their quality, already so superior, until the day when our exchanges with the continent are carried on under a more liberal system.

I have, &c.

(Signed) Léon Arnoux.

On Glass.—By G. Bontemps, Glass Manufacturer, Chevalier de la Légion d'Honneur.

M. Bontemps on Glass.

To the Right Honourable the Lord Stanley of Alderley, President of the Board of Trade, &c.

My Lord,

Awards of the Jury.

I. If the prizes which were awarded after the termination of the French Exhibition, were to be taken as a test in deciding on the present state of the manufacture of glass, it might be supposed that in respect of this branch of industry, England only holds the fourth rank. France obtained the only two great medals of honour which were awarded; of the six medals of honour, France obtained three, Germany two, and Belgium one, whilst to England were adjudged only silver medals, or medals of the first class as they were called, but which lost much of their value since the juries did not act in accordance with the Imperial decree, which laid down the principle that the gold medal was only to be awarded to products of unrivalled merit. Of these silver medals England only received three, whilst France obtained eleven, Germany seven, and Belgium three. We omit all mention of the medals called second class, since amongst the products to which silver medals were awarded, some may be considered so ordinary as to give one but a poor idea of those which received bronze medals.

We are thus naturally led to inquire whether English glass is really of an inferior kind; or whether, for some reason which can be explained, it did not meet with due appreciation.

The jurors for Class XVIII., which, according to the French classification, included glass and pottery, were, no doubt, highly scientific men; some of them were perfectly conversant with the ceramic art, but it must be admitted that they were incompetent judges as regards glass. It is the custom in such cases for the jurors to call in the aid of practical men upon whose judgment they can rely, provided always that their communications are not of a confidential nature, which might give rise to a suspicion of partiality. But on this point, even, the correctness of the decisions with regard to glass manufactures in general may be called in question, and we must add that the British exhibitors did not obtain from the English jurors for Class XVIII. that support which they were entitled to expect. Mr. J. Hartley,

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who was a most fit representative of the glass trade, retired after a few preliminary meetings; and it cannot be denied that the English jurors in general did not possess that spirited national feeling which animated the French jurors in 1851, and prompted them to advocate the claims of the French exhibitors in the sub-committees and before the Council of Chairmen. Assuredly the English jurors in Paris did not do their utmost to call the attention of their colleagues to the special qualities of the several sorts of glass exhibited by the English manufacturers; and we may venture to add that those manufacturers did not appear to be very desirous of being fully represented at the French Exhibition; whilst nearly all the glass works in France sent innumerable specimens of their productions, and from every part of Germany, and more particularly from Bohemia, were contributed the most beautiful works in coloured crystal, which were grouped and displayed in a most tasteful manner. England sent only a few samples of her glass manufactures, and even that seems to have been done most unwillingly. The splendid productions from Pellatt's flint glass works were sought for in vain; Messrs. Osler (after urgent solicitations from a high quarter) could only be persuaded to send one of those *chef d'œuvres* which they manufacture with so much skill and taste. A few samples of flint glass were exhibited by Mr. Copeland and by Messrs. Rose and Daniell, but although their brilliancy and whiteness were unrivalled, it was quite evident that they held but a secondary place in the beautiful display of porcelain and china which was made by those exhibitors. Independently of Messrs. Osler's contribution, the Birmingham district, where the manufacture of glass gives occupation to so great a number of persons, was only represented by a few specimens sent by Messrs. Lloyd and Summerfield, the merit of which could not be discovered in a dark gallery and under obscured windows.

England not well represented.

Great Britain produces very large quantities of plate glass, but not a single sample was sent to the French Exhibition. It might be asked whether the manufacturers were induced to abstain from exhibiting by a consciousness of their inferiority. We can by no means admit this supposition, more especially as we remark that the most important glass works in Belgium, particularly the St. Marie d'Oignies plate-glass works, which enjoy a high reputation, also declined to exhibit. We are inclined to attribute their absence to another cause. Many manufacturers, and especially those of the highest class, object to take part in any

exhibition at which prizes are awarded, as being in many cases calculated to mislead the public, and injure a legitimate and highly established reputation. They know by experience that a manufacturer of uncontested superiority will often receive an inferior award, whilst a first-class medal is granted to a competitor, whose productions are not so much valued by the trade, but who may have exhibited exceptional works, which he would be unable to supply on the usual terms. We admit that in some cases the Exhibition of 1855 seems to have justified that opinion, and we feel convinced that a universal exhibition will only acquire the real character of a true display of the industry of all nations, when it is positively determined to make no distinctive awards, but to constitute the public the sole judge.

Although we have stated that British glass was not properly represented, we maintain that it certainly deserved more than the few inferior prizes which it received.

Scope of this Report.

Your Lordship will doubtless excuse these few prefatory remarks respecting the results of the Exhibition of 1855. We have thought it important to make this protest, especially as many of those who will read this report may not have been able to visit Paris last year. It is not our intention to revise the decisions of the jury for Class XVIII., but to examine all the different kinds of glass that were exhibited, in order to ascertain the present state of the manufacture, the progress which has been made, and especially that which it is desirable to realize.

In order to proceed methodically, we will examine in succession all the sections contained in Class XVIII. The subdivisions adopted by the French Imperial Commission, with reference to glass, were as follows:—

1. General processes of glass manufacture, and raw materials.
2. Window and plate glass.
3. Bottle and common table glass.
4. Flint glass.
5. Ornamental glass of various kinds; glass for optical instruments, enamels, &c.

As we intend giving a short notice of the history and progress of each kind of glass manufacture, it will be preferable to take these subjects in their chronological order; as for the raw materials they will naturally be considered with the different kinds of glass for which they are used.

II. Glass, which is at the present time so useful, not to say absolutely necessary, was originally a rare article of

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ornament and luxury. History and antique monuments bear testimony to the skill with which the art of glass-making was practised in the remote ages, and which even now cannot fail to excite our admiration. It is unnecessary here to institute an inquiry into the origin of glass, or refer to Pliny's fable, which does not deserve the least credit; we would recommend those who desire to investigate the history of glass, to read the authors who have written on the subject, and especially the highly interesting work of Mr. A. Pellatt, M.P., on the curiosities of glass making.

Outline of the history

We will state, once for all, that the specimens of glass from Syria, Egypt, and ancient Italy are chiefly articles of luxury; namely, embossed or moulded reticulated vases, glass mosaics, millefiori, imitation pearls, &c. The greater part of these, as, for instance, the well known Portland or Barberini vase in the British Museum, are positive *chef d'œuvres*, not only on account of the high degree of art displayed in their manufacture, but also as furnishing evidence of the many difficulties which have to be overcome in glass-making. Even now that glass-blowers have attained great skill in the production of reticulated works, there are many antique vases which they would find very difficult to imitate. For instance, we doubt whether they could make those small urns, with white and yellow festoons upon a blue ground, which were chiefly produced in Egypt.

The glass works in Phœnicia and Egypt, and those which were established at a later period in Italy, about the time of the first emperors, produced nothing but vases and cups for the tables of rich men, or urns and lachrymatories for their tombs.

We must, however, observe that in those times glass was not a very pure substance, and although Pliny says respecting the glass cups then in use, "Those are most esteemed which by their clearness and whiteness most resemble rock crystal, and indeed, we so much delight in drinking out of a clear glass, that it has superseded the use of the silver or gold cup,"* we may rest assured that the clearest and whitest glass of that time was scarcely to be compared to our pane glass, and was therefore very inferior indeed to our flint glass. We are also quite sure that the two medium-sized vases which, we are told, were sold in the reign of Nero for six thousand sesterces,† were not made of *clear* and *white*

* Maximus tamen honos in candido translucente quam proximâ crystalli similitudine, usus vero ad potandum argenti metalla et auri pepulit. . . .

† Sed quid refert, Neronis principatu, reperta vitri arte quæ modicos calices duos quos appellabant *Pterotos* six millibus venderet. . . . —*Plin. Hist.* lib. xxxvi.

glass, but were probably some of those extraordinary productions of which the Portland vase gives us so high an idea, on which the artists, whose cameos are so much admired, did not disdain to emboss bold bas-relievos, with a talent quite worthy of the highest stage of Grecian art, and for which a wealthy Roman could not pay too large a price.

As for the raw materials used by the ancients, they are well known from the specimens transmitted to us; and the glass which they produced may serve to aid us in our inquiry respecting the knowledge they possessed of metallurgy. It is evident from their variously coloured glass, that they used iron, copper, gold, silver, antimony, arsenic, cobalt, and manganese; but they had but an imperfect knowledge of the mode of purifying the alkali, in order to make white glass, and many centuries were destined to elapse ere this result could be achieved.

Venice. According to her early writers, Venice was the mistress of the art of glass making almost from her foundation; her productions would even lead us to suppose that the art was imparted to her by direct tradition from the Romans, and that her glass makers had immigrated to that part of the country at the time of the invasion of the barbarians.

The Venetians have, in fact, manufactured with much taste, almost all those kinds of glass, which had been produced in olden times; and the want of clearness of their white glass was fully redeemed by that lightness and peculiar elegance of form, which is so seldom attained by the workmen of the present day.

Gaul and Germany. According to various writers, the art of glass making seems to have been known in Gaul and Germany at a very early period of the Christian era; but with the exception of stained glass for windows no great progress had been made in those countries for many centuries, and it was in Bohemia that the Venetians first encountered the rivals who were destined soon to surpass them. It was in the production of white glass especially that the Bohemians evinced their superiority; with pure quartz and lime, and the potash obtained by burning the trees of their immense forests, they produced, of course, a whiter glass than the Venetians could make with sand and soda extracted from seaweed; the small proportion of saltpetre which was added, being insufficient to correct the impurity of the alkali. The Bohemian crystal was therefore for a long time held in the highest estimation, and was only destined to lose its fame, when flint glass with lead was produced in England.

England. It is difficult to fix the exact period when this glass was

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Flint glass.

first made. The learned author of the article on porcelain and glass manufacture in the "Cabinet Cyclopædia," says, "The manufacture of flint glass was first begun in England in the year 1557, at Savoy House, in the Strand, and in Crutched Friars. In 1635, Sir Robert Mansell obtained a monopoly for making this kind of glass, in consideration of his being the first person who employed pit-coal instead of wood in the furnaces. The art could not at this time have reached any degree of perfection, as permission was further conveyed by the patent for importing drinking glass of fine quality from Venice, and another half century elapsed before the country became independent of foreign supply for such articles."

It cannot be inferred from the above quotation that flint glass, *with lead*, or silicate of lead and potash, was made in the year 1557, or even by Sir Robert Mansell in 1635; we must conclude that it was a mere alkalious silicate, and for this we have the authority of Dr. Merret, an English writer, who, in the reign of Charles the Second, annotated the "Art of Glass Making," by the Florentine Neri. He says, "Amongst us, in England, we make use of several sorts of *frit;* the first is the frit of flint glass, which is a mixture of roquette salt and sand; the second is the ordinary frit, &c."

This flint glass, therefore, was nothing more than a silicate of soda, and we find further confirmation of this fact, in another note by Dr. Merret, to a passage in which lead glass is mentioned as being used on the Continent, merely for the imitation of certain gems: "*the glass with lead is not used* in our glass works in England on account of its great brittleness. . . If this sort of glass were as solid as the usual crystal, it would be quite superior to any other on account of its colour."

There can be no doubt, therefore, that up to the year 1665, crystal flint glass, of the same kind as that of the present day, had not been made in England. But when in 1635, as has been stated above, the use of pit-coal was introduced for melting, it was perceived that the substitution of coal for wood injured the colour of the glass. To overcome he pernicious effects of the smoke, the melting pot was covered with a clay cupola, which gave it the shape of a short-necked retort. It was found, however, that the melting metal thus protected from the smoke, was not exposed to the action of so high a temperature as when in open pots. The consequence was that either the process of melting occupied a much longer time, or else, in order to make it shorter, it

became requisite to increase the proportion of alkali, which deteriorated the quality of the glass. Having these difficulties to contend with, the manufacturers were gradually led to use a metallic *flux*, the oxyde of lead, and in that manner was made the whitest as well as the brightest glass that had ever been produced, and which far surpasses the Bohemian and even the rock crystal, which appear pale in comparison, the diamond only exceeding it in brilliancy.

We may conclude that it was towards the end of the 17th century, that this remarkable result was obtained, since flint glass appears to have been already used for some time as table glass in 1755, when the celebrated optician, J. Dollond, made his first experiments in achromatism.

France. It was only towards the end of the 18th century that flint glass, similar to that made in England, was first produced in France; and we may add, that for a long period, owing to the inferior quality of the red lead and potash, and partly perhaps to the inexperience of the manufacturers, flint glass was not the splendid production which we now admire. For many years, however, by a better preparation of the component parts, flint glass has so far surpassed the Bohemian, as to defy comparison; indeed, the Bohemian glass works could not be kept in full employment were it not for the cheapness of their productions, with which flint glass cannot compete.

Rivalry of Germany. For some time the Germans did their utmost to resume their superiority in the manufacture of glass; but finding at last that they were unable to struggle successfully against the lead flint glass with their silicate of potash and lime, which can never produce anything more beautiful than rock crystal, they resorted to the plan of ornamenting their glass. In this way they introduced medallions painted with oxyde of silver, of a golden transparent yellow, to which they gave fresh lustre by cleverly engraved little drawings; they also added ornaments in coloured glass, and by these means re-established to a certain extent the demand for their productions. Tourists visiting Germany did not fail to bring back with them beautiful little specimens, and a taste for them was soon very generally created.

This fancifully coloured crystal of Bohemia has been in many instances successfully imitated in the glass works of France, and in some of those of England, but in this direction the Germans have generally taken the lead. They are constantly bringing out new objects, often after the old Venetian examples, but they generally contrive to give them an appearance of novelty; for instance, they have recently

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adapted to works of a very large size, the *craquelé*, which was formerly only applied to a few small objects of white glass.

The *craquele*.

The *craquelé*, which Mr. A. Pellatt calls *frosted* glass, and of which he explains the process of manufacture in his "Curiosities of Glass Making" (p. 46), has been this year the greatest novelty of the Bohemian manufactures, and was produced in every form and colour. We must own that novelty seems to be the only merit of these productions. We might naturally desire to have amongst a collection of small objects of crystal, a specimen of frosted glass, by reason of the singularity of its appearance, which resembles rather an accidental occurrence in the making, than an ornamentation produced intentionally; but although this rough surface, which is kept clean with much difficulty, and which divests the glass of one of its chief advantages, may for a short time please the eye as a curiosity, it will never be the foundation of a tasteful and durable manufacture.

As we have already stated, the French glass manufacturers have often successfully contended with the makers of the Bohemian coloured glass, and the same may be said of the English manufacturers, although they have in general confined themselves to the production of white crystal. They thought, and with much reason, that there never would be more than a temporary demand for ornamented crystal, millefiori, craquelé, &c.; but that white crystal, the substance *par excellence*, our production of which is so superior to that of past ages, would always be in request, when most of the coloured crystals had been condemned to be packed away in the innermost recesses of the warehouse.

Necessity of progress.

There is, however, a danger against which the glass manufacturers of France and England must be on their guard. The day will come when the German manufacturers will have exhausted all the fanciful combinations of colouring, which their imagination may teach them, and then they will likewise find out that white crystal is the finest substance of all, give up the use of silicate of potash, and take lead and potash for the basis of their glass. As their lead is good, their fuel and labour cheap, their workmen clever, and their means of communication increasing every day, a very active competition is to be dreaded from them, the evil effects of which will most assuredly be felt by those glass makers who in the meantime have made no progress; and in this respect we have no hesitation in stating that the British manufacturers have been too supine, and have remained satisfied with their ancient reputation for superiority. The specimens exhibited from the flint glass works of Baccarat, of St.

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Louis, and of Clichy, and the display made by the Germans, bear testimony by their number and variety to incessant efforts and immense activity; this constant exercise of the imagination in making coloured glass and objects of fancy, has also placed them in the right direction as regards the economical means of manufacture; and we may venture to add that, generally speaking, the physical and chemical knowledge of the heads and directors of the glass industry in Germany, and more especially in France, is more complete than that of those in England, where, exclusive of the principals, are only to be found managers and foremen possessing nothing beyond the simple practical knowledge of common workmen. The consequence is, that if we take a retrospective view over a certain number of years, we are certain to observe a more marked progress in the glass manufactures of the Continent than in the flint glass works of Great Britain, many of which have not yet turned to their profit the repeal of the excise duty, by modifying the construction of their furnaces so as to increase their power of production. On the Continent, the flint glass blowers labour from Monday to Saturday, for full sixty hours, in the furnaces where wood is used, that is to say, alternately melting and blowing; and for 120 hours in the coal furnaces, where the blowing is continuous, the men being relieved every twelve or every six hours; whilst in England the flint glass blowers only work from Monday to Thursday evening, or to Friday, at the most.

Judging by the Exhibition of 1855, it would not be easy to point out any recent improvements which have not been introduced into England, with the exception of the details of interior management, which are not without considerable importance. We ought, however, to mention the practice of moulding in wooden moulds, found so useful in Germany and France, but which has scarcely been introduced into England. Some explanatory observations on a few technical points may not, therefore, be deemed irrelevant.

Manufacture of German crystal.

We have already observed that the German crystal is nothing more than a silicate of potash and lime melted in furnaces fed with wood. This glass is naturally very hard, and when once it has begun to cool, it is a long time before it resumes the malleability required to work it. Let us take, for example, one of the commonest and least complicated productions, a tumbler, and suppose that it is to be made in an English furnace. The metal is first gathered by means of the pipe in the pot, and the blower makes it round on the marver, blows it, and forms the bottom; an attendant boy then applies the hot pontil to the bottom of the tumbler,

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to which it adheres, and the blower detaches the tumbler from the pipe, and then holding it by means of the pontil he heats the upper portion in the working hole, cuts the heated part with scissors, so as to make it even, and finally heats it again, in order to give it its proper shape. (*See* Glass Manufacture, "Cabinet Cyclopædia," p. 171, &c.)

Wooden Moulds.

These operations are all executed with great rapidity in the case of flint glass; but in the case of German glass, the heating, cutting, and opening of the tumbler would be a very long process. In order, therefore, to simplify the operation, the German manufacturers use a wooden mould, the interior of which is exactly the shape of the article they propose to make. The object of using wooden moulds is to prevent any mark being left on the glass, as is the case with metal moulds. These moulds are made all of one piece for such articles as tumblers, the upper part of which is as wide or wider than the lower, and the profile of which does not present any interior angles; but for such things as decanters, &c., they are made of two parts united together by hinges. The blower gathers his glass with a pipe, and after giving it a preparatory shape by blowing it, places it in the mould, blows it, and at the same time turns the pipe on its axis. A few seconds suffice to give the *paraison* the form of the interior of the mould. The workman has then only to detach the glass nearest the pipe, and the tumbler having been annealed, cut, ground, and polished, is finished.

This is the reason why the Bohemian wine glasses, tumblers, &c. do not have the mark of the pontil on their bottom, and that the edge, instead of being reburnt, bears marks of having been cut. In the case of a wine glass, the blower prepares and blows the cup of the glass in the mould, and then fixes on to it the stem and the foot, and detaches it from the pipe, as before. The wooden moulds are from time to time immersed in water, in order that they may not be burnt too rapidly, and may by that means serve to mould a great number of articles without their dimensions being sensibly affected. When it is found that the heat has altered the form too much, new moulds must be used; but the first can be re-turned, and serve again for articles of a size larger.

When such articles as decanters or vases are being blown in moulds made of two parts, the workman never ceases to turn the pipe on its axis, and no mark is, therefore, left on the surface of the blown article by the joints. As all the German glass manufactures are, without exception, made in this manner, we can easily comprehend why so much importance is given to the workshops where these moulds are

made, and why so much dexterity and precision is required of the men in this department. M. Bontemps on Glass.

The uniformity resulting from this process has produced its effect on the French manufacturers who have visited the glass works of Bohemia. They have imported the German method, which had been at first established in that country on account of its economy, but which had afterwards been regarded as an improved process, because of the uniformity with which the more complicated articles were produced. The wooden moulds have occupied in consequence, within the last few years, a very important place in the glass manufactories, and are found most useful, especially in the production of opal and coloured vases, which are thus made more rapidly and of a perfectly correct outline. We have no doubt that wooden moulds will prove of great service to English manufacturers also, when they become better understood and more extensively adopted. Importation of the German method into France.

We will not dwell upon moulding by means of metal moulds, by which ornaments similar to those obtained by cutting are produced. This process, much used in consequence of the improvements effected in *pressing*, in the United States, seems now to be on the decline. There appears to be now a general feeling that a glass, a vase, or a decanter should be plain, and are then in better taste than when loaded with ornaments often faulty in design, which never have the neatness obtained by cutting, and the interstices of which are so liable to fill with dust. This style will, however, continue to maintain its ground, provided taste and discretion be shown in respect to the ornamentation.

The process of cutting, on the other hand, will always enhance the value of flint glass, which derives prismatic effects from that operation. This is the principal object which should be sought after in cutting, and we will add that it would have been well, had the glass-cutters represented in the Exhibition of 1855 been better artists, or had they been furnished with better models to copy from. There is room for improvement here, and we think it useful to point it out, and to recommend the study of cut-glass ornaments to the Schools of Design. It is necessary to have as a model, not only a correct and tasteful drawing, but it should also place in full relief the essential qualities of the substance. In this respect we cannot refrain from saying that Messrs. Osler seem to have attained perfection in their splendid candelabrum. General beauty of form, boldness of adjustment, purity, whiteness, and brilliancy,—all these qualities were united in this magnificent sample of English flint glass. Osler's candelabrum.

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Some impartial persons may have given the preference to the chandeliers of Baccarat, owing, perhaps, to their being made for wax candles, the numerous divisions of the upper part giving them a coquettish appearance, in which the candelabrum of Osler, arranged for a few gas-burners only appeared deficient, and was therefore, perhaps, not quite in accordance with the *ensemble*. Other persons gave a proof of their incompetency as judges, by asserting that Messrs. Osler had only exhibited one candelabrum because they found it too difficult a task to produce two, as Baccarat had done. As for ourselves, we have but a single fault to find with Messrs. Osler, and that is for sending only one specimen of their production, to the Exhibition, while the glass manufacturers of France and Germany were remarkable for the number and variety of their articles.

These objections, however, have not much weight, and do not sufficiently explain, and still less do they justify, the award of a third-class medal to Messrs. Osler; due justice was not done to the crystal, far superior to that of any other exhibitor, and in which England maintains a superiority, which should have been carefully pointed out to the French manufacturers, with the view of stimulating them to make further improvements.

Difference of English and French flint glass.

We will now attempt to show in what manner the English flint glass differs from that produced in France, leaving the German flint glass out of the question.

If you enter a glass shop in London you find in it articles of great splendour and of unequalled whiteness and brilliancy, but near these admirable productions, you often perceive others that are of a bluish or nearly purple tint, and still more often having a dark hue, which is the result of the neutralization of the greenish colour by the manganese. If, on the contrary, you visit a *magasin* in Paris, you cannot fail to remark the great uniformity with which the white flint glass is manufactured; it does not rise to the maximum of brilliancy, but, at the same time, the eye is not offended by any of those bluish or darker tints alluded to above.

When English flint glass is fine (and this is most often the case), it defies all comparison, and it is fair to add that, for some years past, irregularities of colour have been less frequent, and we are of opinion that this improvement is principally due to the use of a better kind of sand. In former times most of the English glass works made use of the Isle of Wight sand, which is far from being pure. It was, therefore, found necessary to correct with manganese the colour produced by the oxyde of iron contained in the

sand; and glass manufacturers are quite aware how little the oxyde of manganese can be relied on in its effects. A purer sand, procured either from America or from France, is now very generally employed in England; and here it is proper to remark that, if the French and American flint glass is deficient in brilliancy, the *dead appearance* mentioned by Mr. Pellatt is not attributable to the sand used in the glass works. Professor Tennant asserted before the Society of Arts, that the Fontainebleau sand contains a large proportion of carbonate of lime. We are prepared to admit the truth of his assertion with respect to the sample analysed by him, but it is incorrect with regard to the sort of sand procured from the quarries worked for the French glass manufactories in the forests of Compiègne and Fontainebleau, and in the vicinity of Nemours. The sand from these localities is almost chemically pure, and scarcely inferior to that imported at great cost from the United States.

As a proof that the flint glass of France and America might acquire the intense brilliancy in which they are deficient, we may observe that American sand was used in the manufacture of Messrs. Osler's candelabrum. We believe, nay, we are almost certain, that it is principally in the proper management of the fire, that lies the secret of the beauty and splendour of flint glass.

Use of zinc.

While speaking of white flint glass, it is proper to mention that glass, of which one of the principal component parts is zinc, and which was first exhibited in Paris in 1849, then at the Great Exhibition of 1851, where it obtained a council medal, and finally in Paris again in 1855. This glass, a boro-silicate of zinc, made at the Clichy works, has not as yet been in any great demand. It is perfectly white, but, as Mr. Pellatt has observed, without brilliancy, and therefore, will be unable in this respect to compete with the glass in which lead is a component. In another point of view, as the manufacture of this glass is more costly than that of the silicate of potash and lime used by the Germans, or of the ordinary *gobeletterie* of France, it does not seem to promise much for the future. As we proceed, we will examine the value of the boro-silicate of zinc for optical purposes.

Independently of the two chandeliers of Baccarat and of the indisputably superior English white glass, the most remarkable feature of this section of the Exhibition was the almost infinite variety of coloured crystals and *craquelé*. We must also call attention to the beautiful specimens of *aventurine* sent by the manufacturers of Venice, who, so far, have retained nearly exclusive possession of the fabrication

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of different coloured enamels so much used in jewellery work and in other arts; and the very elegant lustres of M. Heckert of Berlin, formed of leaves and flowers moulded and cut in coloured crystals, which were held together with gilt bronze ornaments, were deserving of much praise. We must not omit to notice the articles exhibited by Mr. J. Hartley, under the denomination of Nineveh glass, not on account of their forms, but as having the appearance of having been found in the excavations of an antique city. These vases were made of a substance called *Porcelaine de Reaumur*, which, in fact, is nothing more than glass devitrified by being exposed for a considerable time to a high temperature. It is well known that all glass may be more or less devitrified, that is to say, crystallized in the same manner as chemical salts, the process being much facilitated by the presence, in the composition of the glass, of a large proportion of lime or alumina. This is the reason why bottle glass may be easily devitrified; if the melted metal be not kept hot enough it becomes *ambity*, which is the commencement of devitrification; the same is the case with window glass when it contains a large proportion of chalk or lime, and it is this latter kind which Mr. Hartley has employed for his Nineveh vases.

Nineveh glass.

It was thought, on account of the hardness which this process gives to glass, that it might be advantageously used for domestic purposes, and the attempts of Mr. Hartley have again called attention to this interesting production, but they have only served to prove once more that this manufacture is not a hopeful one in a practical point of view. Glass is only brought to the state of *Porcelaine de Reaumur* when the temperature is such as to cause the articles to bend under the effects of the operation. It therefore becomes necessary to give them an interior and exterior support by filling them with a refractory matter, and by placing them in a bath of the same substance. The name of *cementation* was given to this operation, and it was imagined that certain substances, such as plaster, would still further facilitate the process of devitrification. We are convinced that sand produces the same effect, and, moreover, that these substances are not otherwise necessary than to prevent, in a certain degree, the objects being deformed; and even to attain this object they cannot always be relied on, as may be seen by an examination of Mr. Hartley's vases. It is easy to understand how costly these articles must become, which, having in the first instance undergone the ordinary operations of glass making, are afterwards subjected to a lengthened and

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expensive process of annealing, producing after all nothing but that which may be easily replaced by cheap pottery.

Mr. Hartley also exhibited vessels made of silicate of soda and lime, for domestic and more particularly for farm uses. Analagous articles are made in some of the French glass works, where scarcely any other substance than *cullet* is melted, almost without the addition of virgin materials. There also are manufactured chemical utensils, which, however, are not so good as those made in Germany. This inferiority is easily explained, for the glass used in Germany, being a silicate of potash and lime, is, as we have already remarked, extremely hard, and therefore well adapted for retorts, tubes, matrasses, &c., which can thus bear a very high degree of temperature, without losing their form.

French goebeletterie.

In France potash is only employed for flint glass; the *gobeletterie*, which is made in very large quantities and at a low price, is composed merely of sand, soda, and lime, and as the glass works where these articles are produced are established in localities where wood is cheap, the manufacturers have succeeded in obtaining glass, the whiteness of which approximates to that of the Bohemian crystal.

England does not possess any glass similar to the *gobeletterie;* in the abode of the artizan, as well as on the table of the wealthy man, is found flint glass, often plain or simply moulded, instead of being cut. It is true that the English workman drinks more tea or coffee than he does wine or water, and that as he generally uses the jug itself out of which to drink his beer, earthenware utensils are far more useful to him than glasses and decanters. The only articles made of common glass in England are the small phials used in pharmacy, &c., which are usually manufactured in the same furnaces as bottles, and made nearly in the same way as on the Continent.

The greater number of the French manufactories of bottle glass sent specimens to the Paris Exhibition; this article is of great importance in France, where the production and exportation of wine in bottles is so very large. The specimens exhibited did not, however, appear to be remarkable for any novelty. Generally speaking, they were more transparent than the bottles in common use, a quality due to the substitution of sulphate of soda for the *kelp*, which was formerly almost exclusively used.

Window glass.

III.—All the different sort of glass of which we have as yet spoken were known to the ancients, but the manufacture of window glass dates from our own era. The silence of

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writers on this subject is a sufficient proof that window glass was not used; and yet the Phœnicians, the Egyptians, and the Romans, who had the means of working glass in so many different ways, were fully able to make panes of glass had the climate more imperatively demanded them. Glass is first mentioned as having been used for windows when the Romans gave themselves up to luxurious living, and is alluded to by Philo, a Jew, in the narrative of his embassy to the Emperor Caligula. Seneca assures us that it was in his time that window glass was invented and first used. These assertions have been contradicted, and it has been maintained that they only referred to the specular stone or talc. The discoveries, however, that have been made at Herculaneum and Pompeii, the two cities which were buried by the lava of Vesuvius in the year A.D. 79, have incontrovertibly proved the existence of pane glass in those places, for fragments of glass are to be seen in the houses, as well as the sashes in which the panes were fixed. The employment of glass for windows must, of course, have spread, as the Romans always introduced into Gaul, Germany, and the other vast provinces of their empire, the luxurious comforts to which they were accustomed in Italy. The want of window glass must have been greatly felt in those cold climates, and yet its use was at first very limited, and it was only in the 4th century that it was mentioned by St. Lactantius and St. Jerome. The first says, "Our soul sees and distinguishes objects by the bodily eyes, as through windows furnished with glass." And St. Jerome speaks of "windows with glass, the panes of which were very thin."

Its introduction into Great Britain.

We doubt whether window glass was introduced into Great Britain at that time. The first authentic account of the use of glass for architectural purposes in England occurs in the histories of the Venerable Bede and of St. Benedict, who flourished respectively as the superiors of the monasteries of Jarrow and Wearmouth in the seventh century. Those members of their order who went on pilgrimages to the Continent brought over as much glass as was required for glazing the windows of their churches, and such was the marvellous effect of this substitute for the opaque material previously used, that the people imputed the change to supernatural agency, and when they saw the light of the moon and stars penetrate into the dark recesses of the church, they avowed a belief that was handed down as a tradition for generations, that "it was never dark in the old Jarrow Church."

About this period James Wilfrid obtained from France

window glass and glaziers to fill in the windows of the cathedral of York, built by St. Paulinus. Glass began to be then generally employed in churches, but it was at a later period only that it was used for private houses. In England especially, where window glass was almost exclusively reserved for the wealthier classes in the sixteenth century, and in Scotland in the seventeenth century, the windows of palaces alone were provided with glass, and that only in the upper stories.

Process of manufacture

There are two different modes of making window glass, of which that which consists in blowing a cylinder (the sheet glass) might claim the precedence; but at all events both processes were employed simultaneously at a very remote period.

It is not our province to give an account of the means employed in the manufacture of crown and sheet glass, which have been recently described by Mr. Henry Chance in a paper read before the Society of Arts on the 13th of last February. Each of these sorts of glass possesses its peculiar merit; the surface of crown glass is perfectly polished, an advantage which is due merely to the effect of heat without the contact of any other substance; while sheet glass, notwithstanding that every care is taken to place it on a smooth area, has one of its surfaces slightly injured by its contact with this area. In addition to this, when the cylinder which is to produce the sheet of glass is spread out, however thin the cylinder may have been blown, its interior and exterior surfaces, which were naturally unequal, are brought down to a state of equality; the one is extended while the other is contracted, and the result is a sort of wavy surface, which may be observed particularly when a window furnished with sheet glass is viewed obliquely from the outside. This appearance strikes an Englishman disagreeably on arriving in a continental town; but we cannot refrain from observing to the manufacturers of crown glass, that a stranger is also disagreeably affected by the unequal swells in the English window panes, as well as by the concentric waves which are also often perceived. Sheet glass does not distort objects viewed from the interior so much as do certain panes of crown glass; but we must own that we are speaking here of crown glass of ordinary quality; the best kind, especially that which has been reflattened, can only be surpassed by plate glass.

One of the greatest disadvantages experienced in the manufacture of crown glass is the waste attendant upon the

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process of cutting in squares, and consequently the impossibility of obtaining panes of large dimensions. It is this disadvantage, indeed, which has caused this branch of manufacture to be almost relinquished on the Continent, where only two firms, one in Hanover and the other in Bavaria, now produce crown glass, and this only on a small scale.

Crown glass.

Two English exhibitors, Mr. J. Hartley of Sunderland and Messrs. Chance Brothers and Company of Birmingham, sent tables of crown glass to the Paris Universal Exhibition, where doubtless many a visitor must have made inquiries as to their use. We will not dwell on the merits of this glass, as there was no question of comparison with foreign productions. Such was not, however, the case with sheet glass, almost all the manufacturers of this species of glass in France and Belgium, and some also from Germany, having contributed specimens of their manufacture.

We will not now inquire what are the qualities of glass generally furnished to the trade in France and Belgium. We are aware that in these countries the inferior sorts are the most in demand, and that the finer and dearer qualities do not meet with a ready sale. The tenant of a house on the Continent does not pay much attention generally to the quality of the glass which the landlord may have used for his windows. It is, therefore, the object of manufacturers to produce the inferior qualities in the largest proportion, although, as we have already observed, the finer qualities are made upon a limited scale. The manufacturers did not exhibit the inferior sorts.

We have to remark that, if the productions exhibited are alone taken into consideration, it will be found that English, French, and Belgian glass was generally of a fine quality, free from defects, and tolerably well flattened, with as even a surface as can possibly be attained in this species of manufacture. It is evident that sheet glass will never acquire so fine a surface as crown glass, unless some method can be discovered of spreading it at a high temperature, and without contact with any area.

Inferiority of English glass.

With regard to the whiteness of the glass, it was by no means equal in all the specimens exhibited, the English glass, in this respect, holding the lowest rank. If not already known to the English manufacturers, we think it right to inform them that foreigners, in objecting to the *swell* in crown window glass, find also much fault with the very disagreeable green tint peculiar both to their crown and sheet glass.

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The glass which would be considered the least white on the continent, is yet whiter than English glass; we particularly direct attention to this important point. Some persons may, perhaps, observe that the continental manufacturers sacrifice quality for whiteness; that a larger quantity of alkali is used, in order to reduce the temperature and diminish the time required for melting; this is an error. We admit that some of the whitest continental glass exudes moisture, which is a defect. We do not deem it necessary to mention where this glass is made, being unwilling to injure any special manufacturer; but we can fearlessly assert that perfect dryness is compatible with whiteness. Some of the whitest specimens, for example the glass of Messrs. Drion, Patoux, and Co. are entirely free from moisture, and would, we are certain, upon analysis give a smaller relative quantity of alkali than any glass manufactured in England. These French glassworks employ the same fine sand as is used for flint-glass, also sulphate of soda and lime, which are almost chemically pure. Their furnaces are also doubtless so contrived as to avoid as much as possible the pernicious influence of coal smoke.

The use of sulphate of soda is general in England, yet the glass manufactured there retains almost the same dark colour as when the manufacturers used only *kelp*. The production of a whiter colour is an improvement which the English manufacturers ought specially to have in view; they at present command the home market by reason of superior quality, but as soon as foreign manufacturers are able to export to England articles competing in quality, the relative whiteness of the foreign glass will undoubtedly, secure the preference of the purchaser.

Sheet glass.

Messrs. Chance Brothers and Co. exhibited, as a sort of model of what this manufacture ought to be, some specimens of sheet glass, the whiteness of which greatly surpassed the productions of the continent. This glass is made on a limited scale, principally for prints and photography. We are glad to draw attention to these specimens, which realize the type of perfection in this branch of manufacture. If the English manufacturer will first endeavour to make the glass in the same manner as on the continent, he will then be able more closely to approximate to the above-mentioned model, which is almost colourless.

Every possible effort should also be made for the attainment of a perfectly polished surface in the manufacture of sheet glass. The glass known by the name of "Patent

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Plate," introduced into commerce by Messrs. Chance Brothers and Co., presents this desirable feature.

Patent plate.

Before the process of casting glass was introduced, there was manufactured at Venice, and afterwards in France and England, a blown glass, generally from a quarter to the third of an inch in thickness, which was flattened out as well as possible, and, being cemented on a stone surface, was ground and polished in the same manner as cast plate glass. This mode of manufacture is still pursued in Germany. Were it not for their limited dimensions, these blown plates possess the same qualities as cast plates. Notwithstanding the thickness of this glass, when the superficial roughness has been removed by grinding, the result is a thin glass. The ingenious idea of the process of *patent plate* consisted in obtaining for even the thinnest blown sheet the evenness and polish of plate-glass, by simply removing the thin outer surface of the glass, reaching to the depth of the cockles (inherent, as we have observed, to this kind of glass), which strike the eye, but which, when the sheet is really well made, have, in fact, scarcely the depth of the 200th part of an inch.

To effect this object, Mr. T. Chance conceived the ingenious idea of extending over a flat surface, covered with a piece of damp wash leather or cotton stuff, each sheet of glass intended to be polished. The pressure directed against the sheet causes it to adhere to the stuff, and by thus producing a vacuum, the entire sheet is maintained in a flat position. Two sheets fixed in this manner are rubbed one against the other in a horizontal position, sand, emery, and water being constantly supplied to keep up the friction. After both surfaces are ground they are polished by a similar process, and at the conclusion of the operation the sheet, which has not lost more than a thin layer of the whole surface, resumes, by its own elasticity, its original shape, more or less curved if it was so before, the entire surface of both sides having a polish as perfect as that of plate-glass.

The manufacture of patent plate has much increased in England. Messrs. Drion, Patoux, and Co. have introduced this process into France, and have contributed samples to the Exhibition of 1855. These specimens are chiefly of a somewhat thick glass, in consequence of the small quantity of patent plate used in France, being generally applied to the production of looking-glasses.

We are of opinion that the *patent plate glass* process is one of the most important improvements which has been

introduced of late years into the manufacture of glass, although some incompetent judges may not have bestowed upon this invention the attention of which it is so well worthy.

Amongst the specimens of patent plate exhibited by Messrs. Chance Brothers and Co. were some sheets of that extra white glass which we have already mentioned. We may add that these sheets really attained the ideal perfection of glass making.

IV. We now proceed to coloured sheet glass, of which stained windows are made. Coloured sheet glass.

As it was our intention merely to give a technological review of the glass exhibited in 1855, we shall not undertake any examination of the windows exhibited, this branch of manufacture appertaining to the *Beaux Arts*, which it does not enter into our plan to discuss. We will simply observe that although many of the best English artists, painters on glass, have altogether abstained from exhibiting, yet that the limited number of productions contributed furnish proof that England, in this branch of art, is on a par with countries which have made the greatest progress.

To revert to coloured sheet glass, it may be said that this kind of glass is at the present day made with equal perfection in France, England, and Germany, all tints being easily obtained, from the most brilliant down to certain neutral tints frequently used for stained windows.

Some amateurs, however, complain of the manufacturers of coloured glass, and allege that the stained windows of the present day are inferior to those of our forefathers, asserting that particular shades are wanting, especially of blue colours for instance, much used in the ancient windows. They also say that the glass is generally *too pure*, and that the impurities of the substance added much to the effect produced by the ancient stained glass.

To satisfy these amateurs, impure glass has been made and tints produced, approaching to and even mixing with those of the ancient glass. Notwithstanding all this, however, the ancient windows are still inimitable. It appears to us that the secret of this superiority has been ill explained, the reasons assigned being equivalent to the assertion that our artists cannot now produce pictures comparable with those of Raphael and P. Veronese, because colours as good as those used by those great masters can no longer be made.

We will mention a fact which tends to elucidate the cause of the perfection of ancient stained glass.

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The French Government having decided on restoring the windows of the Ste. Chapelle of St. Louis, at Paris, the work of restoration was thrown open to competition, each competitor being bound to copy a portion of an ancient window of this monument, and afterwards to produce on a subject allotted to him a window of his own composition. Amongst the latter specimens very few were found, which, with regard to general effect, could be compared with the ancient stained glass, although several of the competitors had succeeded in producing copies which could scarcely be distinguished from the originals,—the tint of the glass, the design, and even the alterations effected by time, all having been faithfully reproduced. The cause of failure therefore was the inability of the modern competitors to produce analogous compositions.

We do not assert that the manufacture of coloured glass has reached the absolute point of perfection. All colours may be produced at will, *flashed* or *potmetal;* but as in the manufacture of stained windows, the glass is a second time exposed to the action of fire, in order to fix the lines and shades of enamel, it often happens that certain colours, especially the red, cannot *stand the fire.* Generally speaking the coloured glass of Germany bears this process better. To obviate the deterioration of colour is an improvement called for in the English glassworks.

The greater portion of glass of a light tint, known as *Cathedral* glass, which is generally used in lieu of white glass, (the white glass of remote periods having in fact rather a dark tint, and also because glass, when too white, produces a disagreeable effect in stained windows), presents in general the inconvenience of not being easily stained yellow with oxide of silver, that colour being frequently adopted for the ornamentation of the windows of the fourteenth and fifteenth centuries. To overcome this obstacle is another very necessary improvement to which we specially direct the attention of glass manufacturers.

Embossing.

Before leaving the subject of coloured glass, we must not omit to mention the process of embossing by means of fluorhydric acid. This process is very ingeniously applied in England, not only to white but to flashed coloured glass, Messrs. Chance Brothers and Co. exhibiting entire windows, and also some frames, as specimens. These gentlemen produce the embossing by a patent process of printing, which simplifies the work, the designs at the same time being better executed, and at less cost. This is another product, the equivalent of which was not to be met with amongst

the specimens exhibited by other nations. In France and Germany, the designs which are to be cut on flashed coloured glass are generally produced by means of wheels and emery. Fluorhydric acid is sometimes employed, but merely for small pieces, and it may with truth be said that the embossing of glass by means of this acid, can in England alone be dignified with the name of a manufacturing process.

Mirrors.

V. We know that the ancients possessed metallic mirrors, but it is not an admitted fact that they had glass mirrors. We will go no further than to say that we think it probable they must have remarked that vases of white glass containing liquids of a dark colour, wine for instance, acted as mirrors, an effect to be reproduced by blackening with varnish one of the surfaces of a flat or convex piece of glass. It is also probably in this manner that the Venetians who seem, as we have already said, to have derived the art of glass making from the Romans by an uninterrupted tradition, were enabled to make their first mirrors. It is certain that the Venetians made at a remote period, mirrors of glass, blown cylindrically, flattened, ground, polished, and afterwards silvered, whilst other glassworks were only producing common glass. They made looking glasses of somewhat large dimensions, of a very pure quality, and particularly remarkable for the cut edges, which formed a species of inner frame, which was further set off by those elegant and tasteful metallic frames still so much admired in these days.

At a later period this manufacture was introduced into France, England, and Germany, but it is only in the last-mentioned country that it is continued on a large scale. The blown looking-glass has been replaced by cast plate-glass. The latter process does not date far back, although one would imagine that it would have presented itself naturally to the minds of the first manufacturers of mirrors.

It is true that some mirrors were made by an analogous process, which consisted in gathering up with the pipe a certain quantity of glass which was cast on the *marver*, and after being flattened by pressure so as to form a square piece, or nearly so, of a thickness as equal as possible, was placed in the annealing kiln. This process was adopted in several glassworks, and amongst others at North Shields, where mirrors were first made in England; but it was ultimately abandoned in consequence of the difficulty of obtaining mirrors of a large size by this means. Looking-glasses of much larger dimensions were obtained by blowing;

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these were also of a more regular thickness, and did not require so much grinding.

In order to succeed in casting large plates of an equal thickness, it was necessary to withdraw from the furnace the entire pot of melted metal, and to cast it on a table. The merit of this bold conception is due to Abraham Thevart, to whom we are indebted for this splendid branch of industry. This man of genius succeeded so admirably in devising all the minute details of this new process, such for instance as the withdrawal of the pot from the furnace, the raising it above the table, the casting of the metal on the table, the rolling it by means of a roller on two rails serving to regulate the thickness, and finally the annealing in the *carquese*, that even at the present day, these operations are executed almost in the same manner as they were at first, in 1688, at the manufactory of the Faubourg St. Antoine, Paris, and afterwards at St. Gobain in Picardy.

Manufacture of plate glass in England.

It is rather a remarkable fact that nearly a century elapsed before the manufacture of plate-glass was introduced into England. The first plate-glass works were established in 1773, at Ravenhead, near Prescot in Lancashire, under the denomination of "British Plate Glass Company." These works are at the present day in full operation. In the beginning of the century, the glassworks of Shields added the casting of plates to their other business, and in the space of a very few years, they succeeded in largely extending this branch of industry. Two other companies are established in Lancashire, as well as one near Birmingham, and another in the vicinity of London. The total produce of all the English plate-glass works is larger than that of any other country. This advantage is due to the demand for rough glass, which is used in large quantities for roofing and glazing railway stations and other public buildings, and, above all, to the use of polished but unsilvered plates for shop-fronts and the windows of mansions.

The operations of grinding and of polishing plates were originally done by hand ; it was much later that machines for polishing, and afterwards for grinding, were brought into use.

The use of rough plate-glass for glazing has been the means of creating a new species of glass, for which we are indebted to Mr. J. Hartley, and which, together with the *patent plate*, may be considered as the most important discoveries which have for many years been made in the general manufacture of glass. It is astonishing, therefore,

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that the jury of 1855 did not more largely notice this invention.

Rolled plate glass.

It is easy to comprehend that, when it is necessary to pour out all the contents of a pot on a table, it is difficult to make very thin plates. By the Hartley process, the workman fills an iron ladle from the pot, and immediately casts it on a table, over which it spreads in the same manner as the large plates, that is to say, by means of a roller sliding on two rails, the height of which regulates the thickness of the plate.

Rolled plate is thus made generally from one eighth to a quarter of an inch in thickness. The consumption of *rolled plate* employed for the same purposes as *rough plate*, and especially for hothouses and conservatories, has already very much increased; for this latter purpose it possesses the advantage of not producing on the plants the effect of a *burning glass*, which is sometimes the case with certain portions of sheet glass.

Two English manufacturers, Mr. J. Hartley, the inventor, and Messrs. Chance Brothers and Co., have sent rolled plate to the Paris Exhibition. The St. Gobain Plate Glass Works, which have recently introduced this process into France, also exhibited some specimens, which, like the sheet glass, had a whiter tint than the English rolled plate.

Manufacture of plate glass on the continent.

With regard to the English plate-glass works, they were not represented at Paris. This will, however, not deter us from speaking of them as if they had been placed in competition with the French cast plate-glass. This last was generally much admired; it was pure, white, and generally manufactured with care. The largest plate exhibited by the St. Gobain Works measured 5·37 metres by 3·36 metres, thickness 0·12 metre; or 18 feet by 11 feet 9 inches, and half an inch in thickness. This plate, which was not silvered, was of very fine quality. Other plates from the same manufactory, nearly as large and silvered, measuring 17 feet by 10 feet 8 inches, were very fine, although the reflection was not perfectly regular; in this latter respect it seemed to us that the plates of a new company at Mont Luçon were superior, from which it would follow that the machinery for grinding in that establishment must be on an improved principle.

Another manufactory, that of Floreffe, near Namur in Belgium, sent an unsilvered plate of large dimensions, well worked, but very deficient in purity. It has not been generally understood how these plate-glass works, which hitherto have only created expectations, have been thought worthy of a medal of honour.

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The plate-glass works at Ste. Marie d'Oignies, of old established repute, and whose productions could in every respect have borne a comparison with the plates of St. Gobain, refrained from exhibiting.

A new establishment in the Rhenish provinces of Prussia, at Aix-la-Chapelle, sent several very remarkable specimens both as regards quality and price. This is the first manufactory of cast plate which has been established in Germany, and with every prospect of prosperity, the demand for plate glass, not only for mirrors but also for glazing purposes, being rapidly on the increase.

The English manufacturers seem more particularly to have devoted themselves to the production of plates for glazing, or at all events they do not appear to have made any considerable efforts towards improving the quality of the plates for mirrors. The consequence is, that the preference is awarded to the French and Belgian plates, even though their price is higher.

Superiority of the foreign plate glass.

We consider it incumbent upon us not to conceal the truth from the manufacturers. We do not wish to name any manufactory in particular, but we say that the English plates are not equal to those of France and Belgium. They are generally less pure, and not nearly so white. Having examined the English plates at the Exhibition of 1851, we do not either admit that they are better worked. Their surface was generally *incorrect*, the parallel lines broken and converging by their reflection. The grinding machinery cannot, therefore, be established on the best principles ; or if the machinery be good, the fault must be in a careless handling of the same. Neither can we admit that English plates are not so white as foreign ones, because they are of a better quality, and not liable to sweat or exude moisture.

A gentleman, whose opinion respecting the plate-glass manufacture is entitled to great weight, observed lately at a meeting of the Society of Arts, that he could not agree in the assertion that the French plate-glass is superior, or that the Fontainebleau sand is the cause of its greater brilliancy of colour ; he had no hesitation in saying, " That if glass could be made white without the use of materials which destroyed its brilliancy, or in other respects spoiled the glass, it would be the perfect colour ; but the French glass had a dead leaden appearance, and a dampness on it, which he attributed to an excess of alkali tending to devitrification."

We regret the necessity of contradicting all these points, but it seems to us that it might be dangerous to the interests of the plate-glass works themselves, to allow such an error

to gain ground. The first step towards improvement is for the manufacturer himself to be apprised of the inferiority of his productions. Let him inquire at the English warehouses, or address himself to the merchants of Hamburg, Amsterdam, or the United States, and he will receive the uniform answer, viz., that the British plates cannot be compared with those of France and Belgium; and, assuredly, if the French plates presented the appearances described above, they could not be in such request.

We admit that the French plates, which are frequently not so dry as they might be, are not entirely free from sweating. This is one of the effects of competition, which sacrifices, in some measure, the quality of the article in order to incur less expense in the manufacture. The quantity of alkali is slightly increased, so as to shorten the duration of the melting process, whilst that of lime is slightly diminished, in order to produce greater whiteness. But we have no hesitation in saying, that the French plates have no tendency to devitrify. We do not deny that it will sometimes occur in rooms, where little care is taken, that French plates may be covered with a slight vapour; but we confidently assert, that this moisture is not sufficient to injure them. It is very well known that the St. Gobain and Cirey manufacturers are accustomed to keep a very large quantity of their plates in stock; some of these are often stored for many years, and yet they never experience any deterioration.

We must add, that the British plates are not free from the defect of exuding moisture; those, for instance, which were exhibited in Hyde Park, in 1851, were decidedly sweating. It cannot, therefore, be said that the manufacturers had sacrificed the whiteness in order to obviate this defect. As regards this point, we admit the equality of the British and French plates, but we repeat that the latter are superior in other respects, an opinion which is borne out by the universal trade of the world.

The French plates have not a *dull dead* appearance, but on the contrary are of a brilliant white, slightly verging on blue—a whiteness due to the purity of the materials employed, and which no atmospheric influence can injure, because it is not obtained by the use of oxyde of manganese.

The English plates, on the contrary, are some of them of a tint inclining to yellow; some are of too deep a blue, others green, but none are really white. It seems, indeed, as if the British manufacturers finding the Fontainebleau sand too expensive, had agreed to say that it is of a bad

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quality. We must not omit to mention that this sand is not employed by the St. Gobain and Circy plate-glass works.

It would be a great desideratum for the English manufacturers if they could succeed in discovering a pure sand near at home; hitherto the attempts to find on the British soil, a sand equal to that of America or of France, have been fruitless. We, therefore, advise the manufacturers to import it from those countries, and to use the utmost care in procuring perfectly pure soda, ash, and lime. Notwithstanding these improved appliances, we believe that the manufacturers will not succeed in making plates much whiter than at present, unless they also introduce some important changes in the arrangement of their furnaces, as also in the mode of supplying the fuel.

These are facts of which they must take account if they desire to see their productions maintain a competition with the foreign manufactures.

Nearly five years have elapsed since the Exhibition of 1851, where the English manufacturers could not but have acquired a perfect conviction of the inferiority of their productions, but during this space of time they do not appear to have made any sensible progress. We maintain that their interests for the future will be seriously endangered, should they thus continue to remain stationary. In expressing this opinion, and in thus passing judgment on their productions, we think that we can dispense with any apology, as the English plate-glass manufacturers seem by their absence to have withdrawn themselves from all control.

Optical glass.

VI. We have now to speak of a production in glass which for a long period was considered important rather in a scientific than in an industrial point of view. We refer to the glass employed for optical purposes, viz., *flint glass* and *crown glass*.

To John Dollond has been awarded the honour of the construction of the achromatic object-glasses, formed of two sorts of glass of different density, which he commenced to make in 1753, in accordance with the theory discovered not long before by Euler. He made use of fragments of table flint glass, also of fragments of crown glass (generally the *bull's eyes*), since which application the names of *flint glass* and of *crown glass* have been exclusively reserved on the Continent to designate the two kinds of glass employed in making achromatic object-glasses.

Dollond never having made achromatic telescopes of an

aperture exceeding two or three inches, was able, without much difficulty, to find fragments of flint glass, and especially of crown glass, sufficiently pure to obviate the appearance of any defect in telescopes of these dimensions.

But when the question arose of making telescopes of greater magnifying power, it became difficult to procure pieces of flint glass sufficiently free from striæ to produce an object glass of four inches diameter: the scientific bodies of France and of England offered prizes for the attainment of this result: the most renowned glass manufacturers of the end of the last century and of the beginning of the present one, endeavoured to solve this important problem. The honour of arriving at the solution of the difficulty was reserved for a man in no way conversant with science, nor even a glass manufacturer, but one who was endowed with indomitable energy, and an extraordinary and persevering spirit of inquiry.

Just as striæ produced by the mixture of syrup and water are destroyed if stirred with a spoon, so as to form an homogeneous liquid, in the same manner, Guinand, of Brennets, near Neufchâtel, in Switzerland, succeeded, by stirring and thoroughly mixing the metal, in producing flint glass free from striæ.

The same idea had struck Professor Faraday, who had been entrusted by the Royal Society of London with the direction of the experiments to be made to produce glass for optical purposes. A man of science and genius like Professor Faraday, could not fail to obtain a remarkable result. He produced flint glass of very great density, a *borate of lead* of complete purity; but, it having become generally known that the manufacture of optical glass had just been regularly established in Switzerland and France, the committee ceased its labours.

It is not our intention here to explain in detail how Guinand's method has been gradually introduced into Switzerland, France, and England. The discovery of Daguerre, developed by the eminent artists who, like him, have followed the study and practice of photography, has also contributed to give a great extension to the manufacture of optical glass.

Since opticians have been certain of obtaining suitable glass, a much greater number of achromatic telescopes have been made. These also possess advantages over the *specula telescopes*, in not being liable, like the latter, to deterioration and to tarnish through atmospheric influences. If at one time the achromatic object glasses could be objected to on

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account of their not being entirely free from sweating, the opticians, especially in England, are now well aware that they can procure in their own country *flint* and *crown* glass quite free from this defect.

Messrs. Chance and Co.'s contributions.

Messrs. Chance Brothers & Co. did not fail to send to the Paris Exhibition specimens of each quality of glass of their manufacture; viz., flint glass of three different densities for *cameras*, telescopes, and microscopes, also crown glass of various kinds, and some extremely thin glass (200 to 300 to the inch) for purposes connected with the use of microscopes, and for experiments relating to the polarization of light.

Amongst the optical glass exhibited by Messrs. Chance, we may cite the prisms of an apparatus for a light-house of the first order. It may be remembered that these gentlemen exhibited in Hyde Park in 1851 a revolving lighthouse, the glass of which had an objectionable green tint. It was not pretended that this glass absorbed a considerable portion of the light emanating from the lamp; but assuredly, in comparing a lighthouse provided with that greenish glass, with a lighthouse as made in France with St. Gobain glass, the preference must justly be conceded to the latter. Messrs. Chance perceived therefore, that there was an indispensable amelioration to be effected, and it may be said that the lighthouse glass which they exhibited in Paris could very well bear comparison with the glass of a French lighthouse in its immediate neighbourhood. We can also add, that we have heard Sir David Brewster observe, (from whose decision on such a subject there is no appeal,) that if a difference existed between the two, the advantage belonged to the English lighthouse.

We must not omit to draw attention to the fact that, although that glass is white, it is entirely free from atmospheric deterioration.

Amongst the optical glass of Messrs. Chance Brothers and Co. two articles are especially deserving of our attention; these are the two discs of 29 inches, the one of crown glass, the other of flint glass. The latter had already been exhibited in Hyde Park in 1851. It was submitted to the examination of the Jury for Class X., composed of Sir John Herschell, Professors Glaisher, Miller, Potter, and Colladon, and formed the subject of a very circumstantial report, drawn up by Professor Glaisher, the conclusion of which was as follows:—"The committee had no hesitation in recommending that a Council medal be given to Messrs. Chance for that disc." This award was ratified by the Council of Chairmen.

These jurors expressed at the same time a wish that

a disc of crown glass might be made to match the flint glass one. This desire has been fulfilled. The disc of crown glass of 29 inches has been exhibited in Paris, and from the scrutiny to which it has already been submitted, it seems to be quite on a par with the earlier production. Notwithstanding that the name of Messrs. Chance does not appear, under the head of optical glass, amongst those who have been deemed worthy of receiving medals (we will not seek to explain the reason of this omission), we are certain that before long substantial justice will be done to these works, the difficulties of which, when they are of such enormous size, and when the results to be attained are of such importance, render their production, so to speak, a scientific event.

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Several French manufacturers exhibited optical glass, amongst others M. Maës of Clichy, whose glass, boro-silicate of zinc, had already appeared at the Exhibition of 1851. Great expectations were entertained from the use of this glass for optical purposes, but the desired results do not seem to have been realized.

Foreign manufactures.

It is conceded by philosophers and opticians, that the glass which would best facilitate achromatism, would be a flint glass possessing a smaller refractive power and a larger dispersive index, and a crown glass having, on the contrary, a greater refractive power and a less dispersive index. In a word, it would be desirable that the refractive powers should be equal, as nearly as possible, whilst the dispersive index should differ as much as possible.

The substitution of zinc for lead, which produces the boro-silicate of zinc of M. Maës, of a density of only 2·65, does in fact realize the first-named result, the refractive index being only 1·52 instead of 1·62, which is that of the ordinary flint glass generally used for telescopes; but as at the same time the dispersive index is only about equivalent to that of ordinary crown glass, it follows that this boro-silicate of zinc can only be employed as crown glass. It possesses therefore no advantage over the latter, and according to the opinion of a learned philosopher of Munich, Mr. Steinheil, this boro-silicate of zinc agrees less advantageously with flint glass than the ordinary crown glass, silicate of potash and lime.

Finally M. Daguet, of Soleure in Switzerland, sent to the Exhibition of 1855 two discs of flint and two of crown glass of fifteen inches and nine inches, for which he received as a reward a medal of honour of the second class. We must suppose that this award was made in consequence of the

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high reputation of the manufacturer, a reputation, which we are most willing to admit, is fully deserved. These discs exhibited by M. Daguet not having been polished on their large faces were not examined with much attention; and we cannot, at the same time, refrain from remarking that from the two discs of twenty-nine inches of Messrs. Chance, several discs of flint and crown glass of similar dimensions to those of M. Daguet, and of perfect purity, might have been produced.

Conclusion.

VII. Such are the remarks suggested to us by the Exhibition of 1855, accompanied by the regret that the glass manufacturers of Great Britain should not have made a larger display of the marvels of their industry.

This Exhibition does not show any remarkable improvement in the general manufacture of glass as compared with that of 1851. If improvements have been effected, which is likely enough, they may, doubtless, be traced in sundry details of the means of production; and, in order to understand them, it is necessary to visit the manufactories.

If we were asked what are the improvements which we consider *desiderata*, especially for the English manufacturer, we should answer as follows:—

1st. *Flint Glass.*—We think that, as far as the substance is concerned, English flint glass cannot be surpassed for brilliancy and whiteness; but we are of opinion that the elegance and purity of the forms could be still improved, and that the cutting and engraving have been entrusted to workmen of very indifferent taste, and devoid of any artistic notions.

2nd. *Coloured Crystals.*—Here all the tints seem to have been easily obtained; but the arrangement and contrast of colours, and the cutting, are questions of art requiring better solutions than they have received hitherto.

3rd. *Sheet Glass.*—Endeavours should be made to manufacture, at prices approximating as much as possible to those of the present day, window glass of a whiteness equal to that of the finest plate glass, and with a surface as perfect as that of fine crown glass.

4th. *Plate Glass.*—In this branch of manufacture the greatest efforts should be made, in order to attain the purity and whiteness of the French glass, to produce plates quite free from sweating, and to obtain also much smoother surfaces, which would be parallel, and would bear the highest polish.

Lastly, as regards *Optical Glass.*—The *desideratum* would be to find two kinds of glass having the widest

possible difference between the indices of dispersion, and the closest approximation between those of refraction. The glass to be of a white and quite translucid substance, free from striæ, and not subject to atmospheric influence.

In conclusion, let us observe that our criticisms have been dictated by strict impartiality. We know how to acknowledge superiority where it is really to be found Our national *amour propre* does not induce us to refuse our homage to the superior productions of another country; but at the same time, we feel that the kind reception which we have met with in England, and the just admiration which we entertain for so many of her works, must not be allowed to blind our eyes to certain imperfections, which it behoves the English manufacturer to remedy.

We are aware that criticisms are seldom well received; yet we feel conscious that, by pointing out these imperfections, we are giving better evidence of our gratitude than we should by merely bestowing commonplace expressions of praise on products which are generally admired.

I have the honour, &c.

G. Bontemps.

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REPORTS.

On Vegetable Products, obtained without Cultivation.—By Sir William Hooker, F.R.S., Director of the Royal Gardens, Kew.

Sir W. Hooker on Vegetable Products.

To the Right Hon. the Lord Stanley of Alderley, President of the Lords of the Committee of Privy Council for Trade, &c.

Royal Gardens, Kew,
7th April 1856.

My Lord,

The following is my "Report on the Vegetable "Products, obtained without Culture, and contained chiefly "in the 6th Section of Class II. in the Paris Universal "Exhibition of 1855, viewed with special reference to "the position which the United Kingdom there holds, as "compared with Foreign Countries, and to the progress, "if any, which has been made since 1851:"—Such being the title of that Report, which your Lordship, as President of the Board of Trade, requested me to undertake.

Subjects reported on

Your Lordship further suggested that I should attend chiefly to *Raw Materials*, and to their application or uses in *Commerce*, in the *Arts*, in *Medicine*, *Domestic Economy*, &c.; while anything bearing upon the chemical or analytical properties of such objects should be reported on by some other individual.

Difficulties arising from the collections themselves; often no catalogues, &c.

In my capacity as Juror of the Class in question, it was my duty and pleasure to make copious notes on the various collections exhibited: without so doing no one could feel competent to the task now imposed. Even then the difficulties were innumerable; for, with the exception of the Algerine collection, and some others hereafter to be specified, the majority of the objects had little or no classification, many being entirely unnamed and unnumbered, and often without a catalogue or any competent person in attendance who could furnish the necessary information. In numerous instances where names were affixed, the nomenclature was incorrect; in others the catalogues were not forthcoming till the very close of the Exhibition, or they were private ones, difficult of access, and full of errors; while (most puzzling of all) in some cases, the catalogues bore no refer-

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ence to the present arrangement and numbering of the objects, but to their previous position in some Museum of the locality whence they were derived. Not a few valuable collections of our section were rendered wholly useless by the absence of arrangement, as well as of names and information; others, and I am proud to say especially those exhibited by the United Kingdom, were remarkable for their excellence in these respects.

Difficulties presented by the regulations of the Exhibition.

So far, as regards individual collections; but, further and well nigh insurmountable difficulties arose from the system of classification required by the regulations of the Universal Exhibition. These are explained in the Volume entitled "*System of Classification, as adopted by the Imperial Commission, preceded by an Alphabetical List of the Products of Agriculture, Industry, and the Arts, intended for the use of Exhibitors, Committees and Juries.*" It proceeds thus:—

1. To settle the general order in which the products are to be arranged in the buildings of the Exhibition;

2. To present, in a logical method, to the different classes of the Grand International Jury, the several articles submitted to their examination;

3. To indicate beforehand to each Exhibitor the place which his products are to occupy;

4. Finally, to guide the French and Foreign Committees, charged with preliminary operations, in the properest mode of forwarding the products, for having them immediately arranged at their fitting places.

The Editor, however, goes on to remark that "a general "classification of all products is too arduous to be easily "performed, unless there exists a long practice in such "things; and that it requires profounder study than the "occupations of the majority of persons who are called upon "to apply it will permit. Many articles, too, being of a "complex nature, are referable to several different classes; "while a certain number may occasion hesitation, or at best "involve researches and considerable loss of time."

The compilers, too, of the catalogues of the works exhibited in the British Section of the Exhibition, complain of the *difficulty* which attends classification; and I have had occasion, in publishing *some remarks on the Vegetable Products, obtained without Culture, exhibited in the East Indian and Algerine collections of the Paris Exhibition,* to say "the "objects thus named comprise what are usually termed "raw materials (matières brutes); yet are they generally "combined with a certain though indefinable amount of "manipulation. When a greater degree of mechanical or "artistic skill is bestowed upon them, they merge into other

" classes, in the shape, for example, of *Dye-Stuffs*, *Caoutchoucs*, " *Gutta Percha*, *Paper*, &c., under Class X.; or as *Drugs*, " under *Pharmacy*, Class XII. The workman's skill trans- " forms various woods into the objects included in Class " XXV. under the head of *Furniture;* while a still higher " artistic talent removes them to the sculptural Class XXIX., " under the head of *Beaux Arts.* It thus often becomes " impossible to draw the exact line between the respective " Classes. Even with reference to the term '*Products obtained* " *without culture*,' there exists the well-known qualifying fact, " that the *Mandiocca plant* (*Jatropha Manihot*) and the " *Palma Christi* (*Ricinus communis*), for instance, yield " the one *Cassava* and the other *Castor oil* both in the *culti-* " *vated* and *wild* state, and so on with many other Vegetable " Products."

Your Reporter, for the above considerations, has included in his Report, certain objects placed apart from Class II. in the Imperial classification. The plan here adopted is to give a brief catalogue of the collections, with occasional remarks under the heads of the different countries whence they are derived. Such a catalogue will be often generalized, detail seeming unnecessary when the majority of the objects are already well known, or when, as frequently happens, they closely accord with those described in the admirable " Reports by the 30 Juries of the Exhibition " of 1851."

Plan pursued; viz. arrangement according to countries, and to the respective importance of the collections.

By arranging our catalogues according to countries, important information is conveyed; they offer suggestive hints on a large scale of the commercial wealth and resources of each given colony or locality, as regards its *Vegetable Productions*, its *Timber*, *Fibres*, *Gums*, *Drugs*, *Tannins*, *Dye stuffs*, &c. From these data, it becomes easy to compare our own possessions with foreign countries, and to arrive at the conclusion as to " what progress, if any, has " been made in this department of the Exhibition since " 1851."

Proceeding, therefore, to classify the Vegetable Products according to their native countries, I find the collections of chief magnitude and interest to be those from India and Algeria. I head* the list with—

* Were there no other **motive** for commencing with the Collection of the East India Company, the fact of two " *Grandes Médailles d'Honneur*" being awarded would be a justification: the one to the Honourable the East India Company itself, the other to Dr. Royle, as " Co-opérateur, pour avoir recueilli et classé une très-belle et très-utile collection de matières textiles, de matières médicales, et autres produits naturels de l'Inde et de l'Archipel Indien."

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I.—INDIA AND THE INDIAN ARCHIPELAGO.

(Dr. Royle, East India House, London, Commissioner).

I. Fibres.

Fibres.

The value of the collection of *Fibres*, in their raw state, here exhibited, is greatly enhanced by the accompaniment of a considerable variety of Ropes, Cordage, Mats, Paper, Clothing, &c., chiefly placed in the *Grand Palais*, along with the other manufactured articles of the East India Company's Possessions. Still more is the importance of the collection increased by the able work, recently published by the Indian Commissioner, Dr. Royle, which is entitled "The Fibrous "Plants of India, adapted for cordage and paper, with an "account of the culture and preparation of Flax, Hemp, "and their substitutes. London, 1855." The book, however, is not confined to the fibrous properties of these plants; it includes all their other uses and products. I follow the learned author in the arrangement he has adopted, commencing with—

The Grasses.

Grasses, &c.

Moonja (Saccharum Munja) is used for making rope, which is so strong that the boatmen of the Indus use it for towing their largest vessels up the stream, even where the opposing current has the greatest force. It is also employed for rigging and other purposes, and its wasted substance, when the fibres are extracted, would be available for coarse paper.

Shur (Saccharum Sara) is available to the same purposes, but is not so strong. Other species of the same genus afford screens and thatch, and are made into writing pens and arrows.

Dab or *Koosha* (Poa cynosuroides) yields rope: it is the sacred grass of the Hindoos.

Sur (Arundo Karka) affords string and twine from its flower-stalks, and materials for chair-bottoms in its culms.

Kooskoos Grass or *Vitivert*, (Andropogon muricatus) is well known, both from the Tatties manufactured of its fibrous roots and the perfume exhaled by these roots; this scent is now fashionable in England. The fibre is not very strong.

Sedges.

Madoorkati (Cyperus tegetum or Papyrus Pangorei) is woven into the beautiful shining Indian mats.

Bhabhur, or *Cotton Grass*, (Eriophorum cannabinum,) is much used for rope-bridges. The fibre is very strong and

silky. As these cable bridges offer frequently the sole means of transit over rivers and deep gullies, this grass may be considered one of the most important productions of north-western India.

Bullrushes.

Patera and *Reree* (Typha elephantina and T. angustifolia)* serve for making mats and baskets.

Screw-Pines.

Keora or *Kaldera bush* (Pandanus odoratissimus) is employed for matting and cordage. (In Mauritius all the sugar-bags are made of the leaves of Pandanus sativus; and when the sugar has been entirely removed from them, in Europe, these bags are sold in London, for instance, at fourpence the dozen, to fishmongers, for the conveyance of small packages of fish.)

Pine Apple Tribe.

Pine Apple, Aloe, Plantain fibres, &c.

Bromelia.—The true *Pine Apple*, cultivated in India, is an imported plant; but the Bromelia Pigna, if it be a distinct species, abounds in the Philippine Islands, and appears to be naturalized there. From it are derived, according to Dr. Royle, the exquisite textile fabrics called, according to their fineness, *Manilla Cloth*, *Grass Cambric*, *Batiste d'Ananas*, which are woven and embroidered by the Nuns of Manilla.

Pita or Agave.

Agave, or *American Aloe*, is naturalized in various parts of India. Its fibre is very valuable.

Aloe.

Most of the so-called "Aloe fibre" is derived from the American Aloe (Agave Americana); but Dr. Hunter, of Madras, has shown that an Indian species (A. Indica of Royle) is very good, the fibre being white in colour, of fine quality, and of sufficient tenacity for textile fabrics, readily taking colours, as orange, red, and crimson. A rope of this fibre bore a weight of 160 lbs., while a similar one, manufactured from Petersburg hemp, broke with the same weight.

Sanseviera.

Moorva fibre, or *Bowstring Hemp*, is the produce of Sanseviera Zeylanica.

* Dr. Royle observes, that from the abundant pollen of these plants a kind of cake is manufactured, which is sold in the bazaars of Sindh as food. It is not a little remarkable that a similar edible is prepared from the same pollen by the Aborigines of New Zealand, and, as far as we know, nowhere else.

Adam's Needle, or Yuccas.

Three species, *Yucca gloriosa*, *aloifolia*, and *filamentosa*, afford good fibre, but are not indigenous in India.

Arrow-root Tribe.

Moseta (Maranta dichotoma): From it the mats, called in Calcutta, Sital-pati, or cool mats, are manufactured.

Plantain and Banana.

Musa Paradisiaca and *M. Sapientum* produce, besides their valuable and well-known fruits, an immense quantity of fibre; and *Musa textilis* yields the so-called hemp of Manilla.

Palms.

Palms,—their fibres.

Besides the valuable and well-known edible products of the palms (farinaceous and saccharine matter, oil, &c.,) their stems and broad foliage supply timber and fibre to a great amount. From a house to a rope and a basket, the natives owe their daily comforts and necessaries to these trees, many of which grow in the Peninsula of India, the Malay Islands, Java, Sumatra, &c. The species of *Cane* (Calamus), remarkable among palms for their long stems, afford materials for seats and bedding, and are much used as sticks and for cables; suspension bridges in the Himalaya being constructed of them. In Java and Japan hardly any other article than cane is employed for the above purposes; even cabinets with drawers are made of cane. Baskets and twine are fabricated from the finer fibres; and the stronger ones are used for the cables of ships, for dragging great weights, and even for the trying service of binding untamed elephants. They combine lightness and tenacity to a wonderful degree, and are often of great length, the strips of cane being sometimes 30 feet long; so that strong ropes, measuring several hundred feet, are made of them. Trifling as canes may seem to be, the dominions under the East India Company have in some years exported from four to five millions of them annually. Many kinds of *Rattan* are yielded by the species of Calamus, as walking-sticks, which are mottled and tinged brown by smoking them, and the sort which is used in the country for the bottoms of chairs. The *Palmetto* (Chamærops Ritchieana) affords ropes, twine, mats, and sandals, as an allied species (*C. humilis*) does, in the South of Europe and Northern Africa. The *Date Palm* (Phœnix dactylifera), which does not yield eatable fruit in India, is very serviceable for ropes and baskets, &c.; while umbrellas, punkahs, and hats, are made from the fibrous foliage of another Palm, the *Chattah Pat*

of the Assamese (Licuala peltata), which articles are remarkable for uniting lightness, toughness, and durability.

The *Palmira* Tree (Borassus flabelliformis) supersedes paper; the natives write, with an iron style, on its leaves; and they use them for thatching houses, &c. *Twine* and a wiry small rope is made of them, and the fine down from the base of the leaves is employed to staunch bleeding wounds.

The best *umbrellas* and *broad hats* are composed of *Talipot leaves*, the produce of two or three species of Corypha, especially C. umbraculifera. The unfurled leaf, as stated by Knox, will cover 15 to 20 persons, while it is so compact and light that when folded together it is no thicker than a man's arm. The *Caryota urens* is also applied to many uses in India; its fibres, called *Kittul*, are as strong as wire, and the woolly bases of the leaves are sometimes employed for tinder and caulking ships. But no substance of the kind can rival, for tenacity, the *Gomuto* fibre, which is brought from India to the western world, under the name of *vegetable bristles*. It resembles black horse-hair, and it resists wet, to an astonishing degree, thus being peculiarly adapted for ships' cables and cordage. It is the produce of the Arenga saccharifera. Each well-grown tree of this kind throws off about six leaves a year, which collectedly furnish 4½ lbs. of Gomuto fibre, sometimes rather more. The fibres may also be removed without injury to the stem: they occasionally measure a yard in length. Three Russian hemp cables have been known to break under a strain which was resisted by a rope made of these fibres, a fact attested by one of the most celebrated ship-builders in Calcutta.

Gomuto fibre.

The *Cocoa-nut tree* is too generally prized to require much remark; but we must not overlook the importance of its fibre, as affording *Coir*, which is chiefly obtained from the husky covering of the nuts, though it may be stripped form the trunk when young in large pieces of natural network, which are available for coarse clothing, for mats and screens, brushes and brooms. In some places *Coir* is the established standard of barter (as cowries are in Africa): its value does not vary; and when it is made up in lengths of a fixed measure and weight, it is used to purchase rice, tobacco, salt, &c. The sea-side nuts yield most fibre; three of them will produce a pound of *Coir*, while ten from the interior give no more in weight, though the *Coir* will be finer. For stuffing mattrasses this substance is considered better in India than hair. Sail-cloth, oakum, and much of the coarse cloth in universal use, called Gunny, are made of it; and Coir cables are coming into esteem in Europe, for their strength and elasticity, and are even replacing chain cables for large ships.

Cocoa nut fibre.

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The various articles (matting, cordage, net-work, brushes, &c.), made by Treloar and Wildey, London, are derived from the fibre which envelopes the cocoa-nut. Bonnets and hats of a light cinnamon colour have been also fabricated by the same ingenious individuals. Dr. Royle is of opinion that the *Gomuto Fibre* might advantageously be combined with *Coir*.

Some idea of the importance of the Cocoa-nut Palm may be derived from the fact, that in the year 1850 Calcutta, Madras, and Bombay respectively imported from other parts of India and from foreign countries *Coir* and *Coir rope* to the value of (Calcutta) 8,800*l*., (Madras) 7,000*l*., and (Bombay) 14,400*l*. And the above statement does not include imports by land; it applies only to those by sea. Other *Palms* might easily be added to this list; but, as a general statement, we may draw attention to the fact, that the Palms which yield fibre in abundance would, doubtless, in the cellular matter which comes to be wasted when their fibre is extricated, present a valuable substance, of more or less importance, and in greater or less quantity, for the purpose of manufacturing that desideratum, paper. They generally, too, inhabit the sea-coast or banks of river, thus facilitating the means of transportation.

Urania speciosa (not a Palm) yields a fibre from which a cloth, not unlike Holland, is manufactured.

Flax.

Flax.

The useful products of this plant (*Linum usitatissimum*) consist of its Seeds and Fibre. In the latter respect Indian cultivation, probably owing to the climate, is less successful than that of Europe, the fibre being comparatively small in quantity and weak in quality, while the oil is more abundant and richer than European Lintseed oil. It is possible, however, that while Flax may not answer as a textile, the stalks, which are allowed to decay in India, would afford material for the paper-maker.

Jute, &c.

Jute, &c.

The *Jute* of India (Corchorus), and the genera Grewia and Triumfetta, both belonging to Tiliaceæ, are remarkable for their tenacious bark. The *Lime* (Tilia Europea), affords the well-known Russian mats, ropes, and platted shoes, and Bast. These articles are supplied in India by the allied trees *Grewia oppositifolia* and *G. didyma*, their inner bark being applicable to the same uses, as well as for making rope, sewing-thread, bowstrings, and nets. As substitutes for Russian Bast, these Indian productions are eminently worthy of encouragement.

Though the name *Jute* is now familiar, only 15 years have elapsed since the article was first introduced to our country. It is the produce of Corchorus olitorius, and C. capsularis, which are potherbs, the leaves being eaten, and are much grown both in Bengal and China for the sake of the fibre. The system of culture now pursued is capable of great improvement, and the quality of the *Jute* would improve accordingly. Most of the Gunny-bags in which Sugar is exported from India are made of it; the same bags are also sent to America for the purpose of packing cotton. Much of the clothing of the poorer classes in India is made from *Jute*. A looni is seen in almost every house, and the coarse cloth called *Megili*, which the women weave, is said to be far stronger than cotton. Another kind is called *Chatee*; it is intended for bedding and packing-cloths. But the chief use to which Jute is applied is the manufacture of Rice and Sugar bags, commonly called *Gunny-Bags*, and known by that name all over the world. Young and old alike find employment in making these articles; women and children spin and weave the *Jute* at home, so do husbandmen, carriers, &c., at their spare moments. The long-stapled Jute is exported; it is only the short and ordinary portions which are used in the country for cloth. The beautiful straight white stems serve for fences and enclosures, and are as valuable as the fibrous portion. *Jute*, *Gunny-Cloth*, and *Gunny-Bags*, were exported from Calcutta in the year 1850 to the value of more than 300,000*l*., North America being the principal customer. The waste ends of the stems have been tried in the manufacture of spirits, and are said to produce a beverage much resembling Corn Whiskey.

Silk-Cotton Tree.

This tree (Bombax) produces a very abundant silky substance in its pods, but it is not strong or long in the staple, and is therefore most useful for stuffing pillows and for wadding. Sterculia guttata is one of the same family, and its bark abounds in very tenacious white fibres, which the natives of Malabar manufacture into cloth, the poorer people contenting themselves with garments made of the bark itself, with no further preparation than washing it. Sterculia villosa yields the *Oadal* rope of Assam, which is very strong and durable. (The same is used for sacks in Madras.)

Indian-Hemp.

Indian Hemp.

This name is frequently applied to the Fibre called *Sunn*, the produce of Crotalaria juncea. From this substance the

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Gunny-Bags of Madras (of which 60,000 were exported from Madras in 1850), are made, and not from Jute, as those of Bengal are. The sacred thread of the Rajpoots was imperatively woven of Sunn. No fibre is so extensively grown in India; and its mode of cultivation and the processes it undergoes are most jealously guarded by the natives, who refuse to admit of any innovation on the practice of their forefathers. An advantage has hence indirectly arisen; for, while they prefer imprisonment to the adoption of European processes in the preparation of the *Sunn*, they take increased pains in the performance of their own mode of rearing and manufacturing it. Cables and Topsails are made of *Sunn*, which have been tested in England and proved of good quality. The *Crotalaria juncea* is cultivated with slight differences in all the three Presidencies; the produce is equally good wherever like pains is taken with it, and the opinion is generally gaining ground that *Sunn* is likely to become a valued article of import in the English market.

Another species of *Crotalaria* (C. tenuifolia, Roxb.)—(a variety of *C. juncea* of most authors), yields a fibre called *Jubbulpore Hemp*, which first attracted attention in the Exhibition of 1851, and was then pronounced by competent judges to afford an excellent substitute for Russian Hemp, which it excelled in strength. The same is the case with *Dhunkee*, the fibre of Sesbania aculeata; a rope of it was found to bear a greater strain than one of Hemp, but it has the disadvantage of shrinking extremely when wetted, and is therefore unsuitable for ships' cordage.

The *Maloo Climber* (Bauhinia racemosa) ascends to the tops of the loftiest trees, often destroying them in its close embrace: its bark is immensely strong and much used by the natives for ropes, though not exported. In the valley of the Jumna River the suspension bridges are made of these ropes. The B. scandens has the same properties, and is similarly used.

Mallows; Malvaceæ.

Mallows, &c. their fibres.

This Natural Family includes the *Mallows* and many allied plants, all abounding in mucilage and affording fibre for cordage in their barks. The cultivated Cotton-plant and many valuable plants belong to it. Among them is the *Deccanee Hemp* or *Paut*, the produce of *Hibiscus cannabinus*, of which the bark is replete with strong and tolerably soft fibres, useful for ropes, sacking, and canvas, but it is of inferior tenacity to the Jute. *Hibiscus esculentus*, *H. Abelmoschus*, and *H. Sabdariffa*, all have fibrous stems more or less silky and strong, and like *H. strictus*, they produce *eatable*

seeds. The bark of *H. tiliaceus* (the *Bola* of the Bengalees) is sucked in times of scarcity, being mucilaginous and nourishing. Several other species have the same properties, so have three kinds of *Sida*, especially *S. tiliæfolia*, which has been raised for the purpose of experiments at the Horticultural Society's Garden at Chiswick from Indian seeds, and which yielded a strong, pliable, and silky fibre, which in China is preferred to Hemp for cordage. A line only half an inch thick, made of it, was found to sustain, after exposure to wet and sun for ten days, a weight of 400 pounds.

To pass on to other tribes of plants, the stringy bark of *Careya arborea* (one of the *Myrtle* family) is used near the Himalayas as a slow match for the match-lock guns of the natives. The *Cucumber* and *Melon tribe*, which are much cultivated for food, abound in fibres of great length. So, with the edible *Jerusalem Artichoke* and *Safflower* (belonging to Compositæ), that portion which is wasted, as the stems, would offer a valuable material for the paper-maker. A plant, allied to the *Periwinkle*, is an extensive perennial climber in the Khasya Mountains, and while its green shoots contain a property which is poisonous to fish, whence the name is derived (*Nerium piscidium*), the fibres are equally destructive to the finny tribes from their adaptability for nets.

Two species of *Marsdenia* yield a fibre used for bowstrings, which are said to last, when in constant use and exposed to weather, for five years; and ropes made from them are proportionably durable. Two kinds of *Leptadenia* are also valuable; the late Dr. Stocks saw well-ropes manufactured from them in Scinde. These plants belong to the *Dogbanes* (*Apocyneæ*).

Various fibres, useful for rope, paper, &c.

Another plant of the *Family Asclepiadeæ*, which is probably the most valuable of them all, is the *Calotropis gigantea*, which affords the *Mudar* or *Yercum* Fibre, so called respectively in Northern and Southern India. Its milky juice and root-bark have highly medicinal properties: the former resembles Caoutchouc or Gutta Percha. Mixed with one-fifth of cotton, the *Mudar* or *Yercum* can be spun and woven into a durable cloth, which takes a dye and bears washing. The price is from 30*l*. to 40*l*. a ton, according to its quality. As the tree which produces it grows wild, and requires neither culture nor watering, this fibre is procurable at very little expense. In fineness, the *Mudar* or *Yercum* equals Flax; in tenacity it rivals, nay, rather excels Hemp. It bears double the weight of Coir-rope and one-half more than Cotton cordage. The silky substance contained within the seed-pods is too short to be spun by itself, but is useful for

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stuffing pillows, &c., and for making paper. (Calotropis procera, Br., the *Uk* of Scinde, apparently yields an equally valuable fibre.)

From a species of *Daphne* (D. cannabina) paper is prepared throughout the Himalayas, of which a huge sheet was exhibited, in 1851, by Col. Sykes, which attracted considerable attention. All this tribe are remarkable for their fibrous bark. Conspicuous among them is the *Lace-bark Tree* (D. Lagetta) of the West Indies. The tenacity of *Mezereon* shoots (D. Mezereon) is well known in this country. The Nepal paper is made by beating to pulp the boiled bark of Daphne cannabina, mixing it with water, and taking it up in sieves and frames. The sheet of paper, when dry, is folded, and sometimes rubbed smooth and polished with a conch-shell, when it presents a fine surface, and receives impressions from engravings better than any English paper. Dr. Campbell, of Darjiling, pronounces the *Daphne-paper* made by the Bhoteas to be nearly as strong and durable as leather, and eminently valuable for official records. Many ancient Nepalese books are written on it. It is easily procurable in many parts of India, but has the disadvantage of burning like tinder.

In the Garrow hills the natives use for their sole garment small cloths made roughly from various barks, chiefly of Celtis orientalis, a tree allied to our elms; sometimes the natural bark, peeled off thin, satisfies them, and serves for a rug by day and a blanket by night.

Hemp is a species of *Urticaceæ*, and called *Bhang* in India, where it is more grown for its intoxicating properties, which reside in the leaves and young shoots, than for the fibre, which alone recommends it to European cultivation. It is allied to the hop, resembling it in the bitter principle which combines with the narcotic. Grain-sacks and strong ropes for crossing rivers are made from hemp, in several parts of India. Two crops of it can be raised in one season, and the Himalayan hemp is of even better quality than that from St. Petersburg. It therefore seems not too much to expect that, as India supplies Europe with the cheapest of vegetable fibres, in *Jute*, so she will also send us the strongest and best in *Himalayan Hemp*.

Of the same natural Family as Hemp is the genus *Urtica*, or *Nettle*, of which numerous species (some now ranged under the generic name of Boehmeria) afford a highly valuable fibre, known and esteemed in Europe. Lines, cordage, and cloth are made of Urtica (Boehmeria) nivea; and it is now ascertained, beyond a doubt, that the exquisite fabric, called *China-grass cloth*, is manufactured from this plant. For

many years after this article had reached the European market, its origin was involved in obscurity. When the fibre of *U. nivea* was first imported, nearly half a century ago, it was coarse: its price was only 12*l.* per ton, and ropes and sail-cloth were the sole articles made of it; but even then the E. India Company was informed that, with proper manipulation, it might be converted into a thread capable of producing the finest lace. Latterly the fibre has fetched so high a price as 120*l.* a ton; and three of the most eminent English manufacturers exhibited samples of the produce, in beautiful China-grass cloth, white and coloured, at the Exhibition of 1851, and received prize medals.

The *Rheea* of Assam, which is a fibre, procured from *Urtica tenacissima*, seems identical in properties and value with that of U. nivea. It is much to be desired that the Assamese should turn their attention to its culture, as well as to collecting the Wild *Rheea*, which grows in immense abundance at the foot of their hills, and is well adapted for the coarse kinds of cordage. There are many other Indian species of Urtica (or Boehmeria) to which the English names of Neilgherry Nettle, Himalayan Nettle, &c. are applied, and which are probably as good, though not so extensively known, as the two first named. The native appellations are comparatively immaterial, as they seem to differ in every Tribe of the Peninsula.

The value of the *Breadfruit Tree* (Artocarpus incisa), whether for food or raiment, and of the *Paper Mulberry* (Broussonetia papyrifera), for the latter purpose exclusively, is too widely known to require much remark. Both are used for these purposes in India, as well as in the Islands of the South Seas; but the availability of them (especially the *Broussonetia*) for paper has not yet been fully tested. There seems, however, no doubt that this tree and its allies the *Mulberries* (Morus alba and nigra) will yet be extensively employed by the manufacturers of paper. The waste shoots, which it is usual to remove from the trees, in order to encourage the growth of young leaves for the silkworms, would afford a large and gratuitous supply. The thin bark, which lies between the wood and the outer rind, has been made into paper in India.

Dr. Royle goes on to say, in pursuing the subject of material for Paper, that "India affords abundance of cheap "and good material for this purpose, even in its common "weeds, and in the refuse of plants used for other purposes. "So that our textile manufactures from the Vegetable "Kingdom need not be confined to Flax and Cotton, when "India offers its spontaneous and excellent fibres; while with

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"regard to cordage for ships and nets, track-ropes, &c., an "equally profuse and excellent supply is secured from the "same country. The softest Flax is excelled in fineness, and "the strongest Russian Hemp in tenacity, by the China "Grass (so called) and the Himalayan Hemp." *

* I cannot close this catalogue of the vegetable fibres of our British possessions in India, admirably as they have been illustrated by Dr. Royle, without reference to an excellent Report recently drawn up by Dr. Hunter on the fibrous substances which were shown in the Madras Exhibition of 1855. I owe the Report to the kindness of Dr. Cleghorn, Professor of Botany in that Presidency. It is in consequence of the impulse given to commerce, manufactures, art, and science by our Exhibition of 1851, that a museum has been formed at Madras. His Excellency, the Governor, and some of the ablest and most enlightened gentlemen there have shown a deep interest in the undertaking; so that while the East India Company's vast collections were being inspected by the Imperial Jury in Paris, the Madras Jury was engaged in a like occupation, on a collection of the products of their Presidency. And though I cannot conscientiously introduce any information arising from the Madras Report, as part and parcel of the Paris Exhibition, yet it were unjust to the East India Company, and still more to the Great Exhibition of 1851, which is the mainspring of it all, if I passed it over in entire silence. These few observations are therefore offered in the shape of a note.

Dr. Hunter, the able reporter, says, "It is impossible to state how far the cultivation of fibrous plants might be carried, and what would be the demand for them in this Presidency, if they were properly prepared for the market; but there is no doubt that the usual careless and slovenly manner in which they are sent out has greatly affected their sale in Europe. This is clearly shown by a comparison of the samples of one or two common fibres exhibited by twenty or more different parties. In almost every instance the relative softness and cleanness of the fibre have been a good criterion of its strength, or the reverse. The valuable experiments as tried by the Principal Commissary of Ordnance, and the Military Board, have proved this fact."

Pursuing the same arrangement as is adopted by Dr. Royle, the *Palms* come first, and the *Cocoa nut* is again pronounced the most valuable because of its fibre, *Coir*. The quality greatly depends on the mode of preparation. Upwards of 3,500 cwts. of it were exported in 1854. In the Arsenal of Madras the coir is extensively used. A prize has been offered in Madras for the best coloured mats in cocoa-nut fibre.

Of the fibre of the Agave or *American Aloe*, called *Pita*, 3,600 cwts. were exported from the western coast in the same year, proving how extensively this plant, not indigenous, but introduced from the New World, has already diffused itself in India. The fibre is strong, but liable to be injured by wet.

Excellent samples of the *Pine Apple* fibre (Bromelia Ananas) were exhibited, white, silky, and pliant, offering a good substitute for flax.

Screw-Pine (Pandanus odoratissimus) was pronounced to be a better material for paper than for cordage. Its aerial roots are used as brushes by white-washers.

Neat table-mats are exhibited from Kimedy, and some teazing brushes, made from the roots of a grass, *Chepooroo Vuleloo*, which would command a ready sale if they could be brought prominently into notice; but the botanical names of the plants which furnish the above articles have not been ascertained, and more inquiry is desirable into this department of raw produce.

On *Plantain Fibre* the remarks are copious and important. Six kinds or varieties of the plant are noticed, yielding fibre of very different quality, a circumstance not sufficiently considered. The plant has a tendency to become stiff, brittle, and discoloured by steeping in the green state, and experiments prove that the strength of the fibre is in proportion to its cleanness. Well-made *Line*, *String*, and *Rope* were exhibited, and a Second Class Medal adjudged for the cleanest and largest bundle of the fibre. Very valuable information on this

2. Woods.

Woods; inferior to the collection exhibited in 1851.

My remarks on the *woods* of the Hon. E. India Company will be brief. Though numerous and correctly named, they were not brought prominently into view, perhaps for want of space; and both my personal observation, and a manuscript catalogue, obligingly placed by Dr. Royle in my hands, will justify my saying, that the collection is very inadequately represented in the "Catalogue of the Paris Universal Exhibition, in French and English," published by authority.

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fibre, which is reckoned the most abundant and perhaps the best in India, is given in this Report under the head of "Cultivation and Preparation of Fibres;" but while it is much too long for insertion entire, it is too important for curtailment.

Of the fibres resembling flax in appearance and other qualities, one of the most promising in the Madras Presidency seems to be the *Yercum* (Calotropis gigantea) called *Mudar* in Northern India, and already described by Dr. Royle. The *common* and the *Indian hemp*, which are both the same species (Cannabis sativa), is said to degenerate in Southern India, and only to succeed in the North-west Province, at an elevation of 3–7,000 feet above the sea.

Good examples of white fibre from Ixora corylifolia are exhibited, made into excellent ropes.

A large and interesting class of fibrous substances, not hitherto noticed as they deserve to be, are the unprepared *Barks* of Trees, many of which yield a strong and ready substitute for rope, while from the quantity of Tannin they contain they resist moisture and retain their tenacity for a long time. With a little care and the employment of simple machinery, admirable cordage, baskets, and mats might be procured, serviceable alike for agricultural and commercial purposes. One of the most useful of these barks is derived from Bauhinia diphylla; to which may be added other species of the same genus, together with the *Banyan* (Ficus Indica), the *Peepool* (F. religiosa), F. racemosa, F. opposita, and other Figs; also several kinds of Acacia (the Stringy Barks of the Australians), Wrightia tinctoria, &c.

A considerable space is devoted to the cultivation and cleaning of Fibrous Plants, as regards the cutting and cleaning, beating, crushing, &c. of *Palms*, their leaves and leaf-stalks, *Screw-Pines*, *Liliaceous Plants*, *Flax*, and its substitutes, *Plantain* fibre, &c., already noticed. Excellent hints are given, and some particular machinery is recommended as the most efficient.

Dr. Hunter's concluding observations are, "*Hemp*, *Jute*, and *Sunn* promise to be the most remunerative of all Indian fibres. They are easily grown, and thrive in all parts of the Presidency. Though not, perhaps, so strong as flax, they are well suited for cordage, coarse cloth, &c. The demand for them is steady, and would probably increase with their improved quality. They could be cleaned, economically, by the usual flax machinery; but the natives must be instructed to use such machines, and liberal encouragement should be held out to cultivators and cleaners of the fibres. Other promising plants, as Hibiscus and its allies, also Ficus, Bauhinia, Grewia, Wrightia, should be subjected to experiment.

"It were important, too, to determine whether tanning or tarring best preserves cordage, and whether some of the numerous Resins and Gum-elastics of Southern India would not advantageously replace Tar.

"It should be borne in mind that it were far better for India to turn her fibrous substances to account in profitable manufactures, than to let other nations reap the benefits of her fertile soil and abundant vegetation."

The List given of Indian Plants yielding Fibre is 43; and Dr. Hunter quotes the common and the botanical name, and adds a brief note on the special use of each.

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There alone do I find any printed record of the several British Colonies; and no more than eight woods are enumerated under the head of India: my own list extends to 37, and I had trusted to render it complete by the help of a more perfect catalogue. Whatever the actual amount may be, the inferiority of this collection, as compared with the Indian collection of the 1851 Exhibition, warrants its receiving but slight notice. On the former occasion, the report of the jury of 1851 contained an alphabetical arrangement of Asiatic (chiefly Indian) woods, a table of the specific weight per cubic foot, with some remarks upon each, occupying five large and closely printed pages; and these were followed by no less than 18 more such pages, devoted to woods, mostly from the East India Company's possessions, arranged according to countries, viz., from Nepal (223 kinds), from Gwalpara, Calcutta, Serampore, Northern Circars, Orissa, Cudeppa, Travancore, Hindostan, Palam-Cottah, Paullghaut, Tinnevelly, Coimbatore, Cannara, Malabar, Rohilcund, Tavoy, Amherst, Tenasserim, Martaban, Arrakan, Chittagong, Mirzapore, Moulmein (mainly Teak), Singapore, Prince of Wales' Island, Borneo, &c. Such a series of *Woods*, ably reported on by Mr. Solly,* might well deter Dr. Royle from removing these bulky objects to Paris, where, too, there might be reason to apprehend that the space allowed for his other collections was too limited.

I therefore shall merely observe, that among the East Indian woods exhibited in Paris were noble samples of *Indian Teak* and *Deodar*, of *Sissoo* (Dalbergia), of *Saul* (Shorea robusta), and *Toona* (Cedrela Toona), which latter is one of

* Besides the Reports of the Jury of the Exhibition in 1851, Dr. Cleghorn has, in his Report on the extensive collection of the *Timbers and ornamental Woods* of the Madras Exhibition (previously noticed), given a classified List, with valuable remarks on the uses, &c. of 155 kinds, grown in that Presidency. He has added much important information with reference to procuring specimens for investigation, recommending that these (unless well known) should be accompanied with portions of the tree in flower or fruit, or both, so that the correct name may be determined. He shows the value of timber to Madras by stating the fact that Madras imports firewood, by sea alone, to the amount of 12,000 tons annually, and that the five following costly woods are exported from the Presidency, in price as follows:—*Sandal-wood* (Santalum album), value 13,794*l.*; *Red-wood* (Soymida febrifuga), nearly 6,000*l.*; *Sappan-wood* (Cæsalpinia Sappan), 1,530*l.*; *Ebony* (Diospyros melanoxylon), 486*l.*; and *Teak* (Tectona grandis), to the amount of upwards of 22,000*l.*

The Jury further append a List of 17 woods, authorized to be used as *Railway Sleepers*, and now under trial on the Madras Line. They are: 1, *Teak*; 2, *Saul, Shorea robusta*; 3, *Dalbergia Sissoo*; 4, *Pterocarpus Indica*; 5, *Zizyphus glabrata*; 6, *Terminalia alata*; 7, *T. glabra*; 8, *Bauhinia diphylla*; 9, *Pterocarpus Marsupium*; 10, *Terminalia Chebula*; 11, *Soymida febrifuga*; 12, *Acacia odoratissima*; 13, *Prosopis spicigera*; 14, *Inga Zeylanica*; 15, *Acacia speciosa*; 16, *Artocarpus integrifolia*; 17, *Bassia longifolia*; 18, *Acacia Arabica*. Also four, of which the scientific names are unknown; viz., 19, *Neene-Marum*; 20, *Sem Marum*; 21, *Coombadree*; 22, *Kaloovoya Marum*.

the most generally useful of Indian Timbers. There were large specimens of *Rhododendron arboreum*, a huge log of *Sandal-wood*, and one of *Satin-wood* (*Chloroxylon Swietenia*). These are, assuredly, among the most useful, and their interest is increased tenfold by the fact, that in the adjoining building (*le grand Palais*) were deposited various exquisite pieces of furniture and elaborately sculptured work made from these very Trees, particularly of *Ebony* and of *Dalbergia latifolia*; also exquisitely cut boxes of *Sandal-wood*; and what was still more curious, many carved articles, consisting of buildings, figures, and even landscapes, made of the soft, white, pith-like interior stems of the *Shola* (Æchynomene paludosa), some of which were upon a very large scale, and attracted general attention from the ivory-like colour of the material and the facility with which it yields to the knife.

3. Tanning Substances.

Tanning substances.

Kino (Pterocarpus Marsupium), from Malabar. Too well known to require description.

Butea Kino (Butea frondosa), from India. An astringent exudation, used for dyeing red.

Do., extract of, from Cochin.

Palachy, extract (Butea superba), from Cochin.

Asacum, extract (Terminalia tomentosa).

Mochrus (Bombax Malabarica), from the Calcutta Botanic Garden.

Subanjuna (Moringa pterygosperma), from N. W. India.

Gall-Nuts (Quercus infectoria). Cultivated in the Calcutta Botanic Garden.

Galls of *Tamarisk* (Tamarix Indica). Western India.

Galls of *Kakrasinghee* (Rhus semialata), from the Himalaya.

Saul (Shorea robusta).

Gambir, or *Malay Kino* (Uncaria Gambir), Malacca. Do., purified.

Mangrove bark (Rhizophora Mangle). Do., purified.

Pomegranate rind (Punica Granatum).

Turwar (Cassia auriculata), from Mysore. Dr. Cleghorn reports this to be the best of native astringents for tanning leather.

Cassia Fistula. India. Less used than the former, but adapted for tanning coarse hides.

Divi-divi (pods of Cæsalpinia coriaria), cultivated, being introduced from South America. Plantations are thriving in the Madras Presidency. Three thousand tons are annually imported to England, chiefly from South America.

Teree (pods of another Cæsalpinia). Chittagong.

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Gall Nuts of Ficus infectoria.

Myrobalans. The dried fruit of Terminalia Belerica and another species, which have lately become of such consequence that imports to England amount to 2,000 tons yearly. From Madras alone 4,150 cwts. (value 850*l.*) were exported in 1853.

Euphorbia. Several species.

Catechu (Acacia Catechu). The bark of this, and of several other species of Acacia, as A. Arabica, A. Farnesiana, &c., is employed for tanning leather. *Catechu* is divided into two kinds, the *White* and the *Brown:* the extract of it is often called *Kut,* or *Cutch,* and *Terra Japonica.*

Calotropis gigantea.

Phyllanthus Emblica (or *Emblica officinalis*). To the galls (fruits?) of this plant the name of *Emblic-Myrobalans* is, not very correctly, given.

Zizyphus species.

Diospyros glutinosa. The fruit is used for tanning, under the name of *Gaub.*

The ashes of *Musa Sapientum, Justicia Adhatoda, Chenopodium,* and *Arum,* are all employed in tanning, on account of the carbonate of soda they contain.

Dr. Cleghorn, in his Report on the Tanning Substances in the Madras Exhibition of 1855, enumerates only ten kinds: most of them are noticed by Dr. Royle, and the collection appears to be of small value. He observes, that the manufacture of Leather in that Presidency is by no means so thriving as it might be, considering the abundance of materials, a circumstance which he attributes to the very low rank of the artisans (Chucklees, or Chumar wallahs). Yet the art of making leather is well understood by the European Tanners at Pondicherry, Hoonsa, Guntoor, Bangalore, and Madras, the article being little inferior to that which is prepared in Europe.

Of all the Indian Tannins, Dr. Cleghorn prefers the *Divi-Divi,* the *Catechu,* and the *Cassia auriculata,* considering them almost equal to Oak-bark.

4. Dye-Stuffs and Colours.

Dye-Stuffs, &c.; no novelty since 1851.

In this department we see but little novelty. The Collections in the 1851 Exhibition were very considerable, and the subject was fully discussed in the Report on Dye-stuffs by Mr. Solly. The articles which I observed, are these:

Indigo (so called), three kinds, the produce of Indigofera tinctoria (which is cultivated in all parts of India), of a species of Ruellia, found in Assam, and of Wrightia tinctoria. To the latter the name of *Pala Indigo* is given.

Annotto and *Racou* (Bixa Orellana). Western India.
Madder (Rubia tinctoria and cordifolia). From Assam.
Munjeet (Rubia Munjista).
Safflower (Carthamus tinctorius). Cultivated.
Turmeric (Curcuma longa). Cultivated.
Nyctanthes Arbor tristis.
Aal Powder (Morinda citrifolia and M. tinctoria.) Central India. Also
Mangkuda (M. umbellata). Malacca.
Cedrela Toona.
Tamarix dioica and *T. Indica.*
Punica Granatum.
Sappanwood (Cæsalpinia Sappan). From Madras.
Terminalia Saja.
T. Belerica. From Madras.
Emblica officinalis.
Oldenlandia umbellata.
Berberis Lycium (from the Himalaya).
Symplocos racemosa (from do.)
Various *Lichens.* From the Himalaya, and from Scinde.*

*Many of the above substances are, it is to be observed, equally available for Tanning. In the absence of any instructive catalogue (the great deficiency in the collection) which might indicate the progress that has been made in the Company's Territories in this important branch of commerce, I am happy to be able to cite some valuable remarks from Dr. Cleghorn. He considers that the methods of dyeing practised in India are generally tedious and complicated; yet the natives have long known how to give beautiful and permanent colours to their cotton goods. The country supplies all the raw material for producing a variety of hues; but where chemistry is unknown, we cannot look for the progress which the application of that science has imparted to the art of dyeing. The process is as rude now as it was ages ago, and any improvement or novelty in colour has been rather due to a happy accident, or an elaborate painstaking experiment, than to skilful combination upon understood principles. Yet the field well deserves labour and research; for, under all disadvantages, the colours produced by Indian dyeing are most brilliant, and a striking proof of their superiority is drawn from the fact that cloths used to be sent hither from Manchester to be dyed, and returned to England to be sold under the name of "Blue Cloths of Commerce." The natives of this part of India dye little else than cotton, and to it they impart durable Reds, Blacks, Blues, and their modifications; but their deep greens, yellows, and other hues appear to be very fugitive.

The great diversity of dyeing substances used in India, including metals, Woods, Flowers, Roots, Barks, Leaves, Fruits, Lichens, Insects, necessitates, of course, different methods of management, and eminently so when *Animal Substances*, as Wool, Silk, and Leather, are subjected to the treatment as well as *Vegetable*. Chemistry has enabled the European dyer to avail himself of colouring substances once deemed of no value, as the Indian *Munjeet*, *Chayroot*, *Logwood*, and *Annotto*, articles comprised in the Madras Collection, together with some little known substances, as *Puply Chuckay* (origin unknown, but which comes from Mysore and Bellary), *Ratinara* (a *Lichen*), and extract of *Casuarina*. Many of the obscurer dyes are well worth a careful trial; they are generally to be had cheap.

Indigo comes first in importance: three kinds are exhibited, but as this dye is not the produce of indigenous plants, and is familiar to every one, I shall not quote Dr. Cleghorn's long and valuable dissertation on it.

Sir W. Hooker on Vegetable Products.

India, &c.

Oils; collection even better than in 1851.

5. Oils.

The collection of Oils of different kinds, Oil-seeds, &c. which was exhibited by the East India Company in 1851 was very considerable, and it obtained honourable notice from the Jury. It is much augmented now, and the subject is, happily, attracting great attention in the different Presidencies. Dr. Hunter, of Madras, is announced as having furnished a vast number of samples. By good fortune, the Report of Lieut. H. P. Hawkes, on the oil-seeds of the corresponding collection at the Madras Exhibition, furnishes much new and valuable information.

Red Sanders-wood (Pterocarpus santalinus) is the produce of a large tree which grows on the Pulicat and other mountains. It was exported in 1854 to the amount of nearly 50,000 cwts., value 6,000*l*.

Sappan-wood (Cæsalpinia Sappan), from Goa. It gives a red but not a fast colour.

Safflower (Carthamus tinctorius), from Cuddapah, &c. This plant yields from its dried florets a very beautiful colour, which, without any mordant, gives to silk and cotton various shades of rose, scarlet, &c., but is not available for woollen substances. The plant is called *Coosum*.

Turmeric (Curcuma longa), from Trichinopoly, Goa, &c. Used for dyeing a yellow but not permanent colour. It enters into curries, and is applied by native females to their faces.

Chayroot (Oldenlandia umbellata), from Tanjore, Travancore, &c. A small biennial weed. The colouring matter resides solely in the bark of the root: it is prized for imparting a vivid red similar to Munjeet, and the celebrated red Turbans of Madura are coloured by its means. Exclusion from light, as stowage in the hold of a ship, is thought to injure Chayroot.

Morinda Bark (Morinda tinctoria, citrifolia, and umbellata). From Eastern and Southern India and the Circars. All these species give a fine red dye, fixed with alum, and are worthy of the dyer's attention.

Aliakoo (Memecylon tinctorium). A small tree, from the Carnatic: its leaves impart a yellow dye.

Annotto (Bixa Orellana). Too well known to require description here.

Pulas (the flowers of Butea frondosa), from Madras and Mysore. Dye red.

Cupla Rung (Rottlera tinctoria), from Mysore. The stellate pubescence (resinous coating?) of the capsule of this large tree imparts a bright orange colour to silk; and experiments instituted by Professor Anderson, of Glasgow, show the substance to deserve a fair trial in Europe; it contains 70–80 per cent. of colouring matter.

Pupli Chuckay, from Bellary and Mysore. The bark of the roots give a yellow dye, but the plant whence they are derived has not been ascertained.

Myrobalans Gall Nuts (Terminalia Chebula, Belerica, and citrina). Oval fruits, which, according to the mordant used, impart a yellow, brown, or black colour, and as they contain much Tannin, are useful also to the Tanner. Though but recently known out of India, already England imports 2,000 tons annually.

Ratinara, a *Lichen*, which dyes black: its value remains to be tested: from Nellore.

Casuarina equisetifolia, cultivated at Pondicherry; a new discovery. The bark gives a reddish-brown colour, deepening to black, and is likely to be valuable.

Lac and *Cochineal*, though precious dyes, can hardly come under the head of vegetable productions. The East India Company has endeavoured to encourage the growth of cochineal, even offering 2000*l*. for the satisfactory introduction of the true Mexican cochineal insect, but hitherto without success.

Dr. Cleghorn closes his Report with an Appendix describing the various processes of dyeing cloth, as practised by Bola Chetty at Madras. The experiments have reference to the various substances enumerated above.

I proceed to give a List of the objects noted in the Paris Exhibition. They include,—

Cocos nucifera.	Calophyllum inophyllum.
Linum usitatissimum.	Pongamia glabra.
Sesamum orientale.	Vateria Indica.
Ricinus communis.	Prinsepia utilis.
Cannabis sativa.	Ramballa oleifera.
Prunus Armeniaca.	Papaver somniferum.
Amygdalus communis.	Guizotia oleifera.
Papaver somniferum.	Buchanania latifolia.
Nicotiana Tabacum.	Vernonia anthelmintica.
Cucurbita Pepo, and Melopepo.	Cuminum Cyminum.
	Croton Tiglium.
Cucumis sativus, and others.	Dipterocarpus (Wood oil.)
Arachis hypogæa.	Terminalia Catappa.
Jatropha urens.	Liquidambar Altingia (Liquid Storax.)
Verbesina sativa.	
Helianthus annuus, perennis, and tuberosus.	Sison Ammi (Bishop's weed.)
Bassia latifolia, longifolia and butyracea.	Benthamia, or Almond oil.
Carthamus tinctorius.	Melia Azedarach (Margosa.)
Moringa pterygosperma (Ben-nut.)	Allium Schœnoprasum and sativum.
Sinapis dichotoma, juncea, glauca, racemosa, and rugosa.	Jatropha.
	Argemone Mexicana.

As the Report of Lieutenant Hawkes, above mentioned, is equally applicable to the series sent by the East India Company to the Paris Exhibition, it is my duty to introduce some extracts from it in this place. The importance of the Indian oils (excluding the essential oils, or Attars) is shown by the reporter, in a Table, exhibiting the gross quantity of vegetable oils and oil-seeds exported from the Madras territories alone to the United Kingdom, foreign and home ports, for the year 1847-8 to 1852-3 inclusive. The first and last only are cited:—

Exports of Oils.

Names.	1847–8. Quantity.	1847–8. Value (*Rupees*).	1852–3. Quantity.	1852–3. Value (*Rupees*).
Cocoa-nuts, dry	74,061 Cwt.	2,90,393	1,51,528 Cwt.	5,30,928
„ Oil	567,801 Galls.	1,26,476	1,457,741 Galls.	3,18,655
Gingeley Seed	17,518 Qrs.	1,60,134	2,51,613 Cwt.	5,31,864
„ Oil	19,520 Galls.	14,766	72,607 Galls.	43,608
Lamp-oil Seeds	1,876 Qrs.	13,736	73,215 Cwt.	54,228
„ Oil	26,379 Galls.	12,637	51,084 Galls.	20,927
Ground Nuts	939 Cwt.	6,315	—	—
„ Oil	—	—	57,207 Galls.	23,603
Margosa Oil	1,587 Galls.	1,240	3,111 Galls.	1,701
Pinnacotay Oil	3,871 Galls.	2,116	—	—
„ Seeds	508 Cwt.	1,353	860 Cwt.	1,167
Cassia Oil	794 Galls.	2,121	30 Cwt.	1,701
Sandal-wood Oil	39 Cwt.	25,619	96 Cwt.	50,037
Cotton-seed	2,458 Cwt.	2,571	80,090 Cwt.	7,613
Fænugreek	301 Cwt.	1,079	1,451 Cwt.	5,322
Mustard-seed	5,328 Cwt.	11,009	16,075 Cwt.	34,048
Castor-Oil	—	—	8,059 Galls.	7,818
„ Seeds	—	—	2,764 Cwt.	4,247
Lint-Seed	—	—	1,106 Cwt.	3,275
„ Oil	—	—	—	—
Fennel-Seed	—	—	—	—

These exports are sent to the following countries:—United Kingdom, America, Arabia, Persian Gulf, Cape of Good Hope, Ceylon, China, France, Maldives, Mauritius, New South Wales, Pegu, Sumatra, the West Indies, and to Bengal, Bombay, Councan, Cutch, Goa, Guzerat, Scinde, Malacca, Travancore.

One hundred and fifteen vegetable Fixed Oils are known to be produced throughout the Madras Presidency and Burmah; 105 of them are greasy and solid oils; ten are wood oils.

Of the first kind, Cocoa-nut, Castor, Ground-nut, Gingeley, or Sesamum, and its variety, Rape, Mustard, and Lintseed, form considerable articles of foreign trade; the first three being exported in the shape of oil, the last two as oil-seed, and Gingeley both as an oil and oil-seed.

In addition to these, the following are largely consumed in India: Lamp (Ricinus,) Ramtill, Koorung, Pinnecotay, Illoopoo, Ponerg or Doopada, Margosa or Neem, Physic-nut, Brumadundoo, Safflower, and Poppy. Of the remainder some are medicinal. Some are prepared only in localities where the plants producing them happen to abound wild. Their prices vary considerably, even in different towns in the same district.

In estimating the worth of an oil-yielding plant or tree, its other products should be considered. *Lintseed*, for

instance, produces, besides oil, the hardly less valuable *Flax*. *Hemp* yields a fibre and an intoxicating resin; *Piney*, a resin; the *Gamboge-tree* affords an important pigment; *Safflower*, a dye; *Pinnecotay*, a soft inferior gum; *Poonga*, a good timber; *Mahowa*, a spirit, distilled from its flowers, &c. &c.; while in the case of the *Poppy*, the oil is of secondary worth to the more prized opium.*

* It would appear that Lieut. Hawke himself exhibits a very extensive and interesting collection of oleaginous specimens in a state of great purity, accompanied by the seeds which yield them. No cost or trouble has been spared to render this collection a complete illustration of the Southern Indian Oils, its value being enhanced by the careful preparation of the substances, to the exclusion of all impurities in the process of extraction. They are as follows:—

1. *Castor-Oil.* (Ricinus communis), of two kinds, the small and the large-seeded variety, the former being the most valuable, and yielding the medicinal oil, the large-seeded kind affording the oil which is employed for lamps. The average produce of oil, from 1,400 lbs. of seeds, is much the same in the Calcutta and Madras Presidencies, namely, nearly 500 lbs of oil, of three qualities, two-thirds of this amount being the best. The two inferior qualities make good soap, but the expense and the smell are both objectionable. The average export of medicinal castor-oil for four years has been (from Madras only) nearly 12,000 gallons annually.

2. The *second kind of castor-oil*, from the large seeds, is extracted by heat, both a roasting and boiling process being employed, by which the colour of the oil is injured and an empyreumatic odor is imparted. It is chiefly used for lamps, and the average export from Madras is 26,000 gallons a year.

3. *Illoopoo oil* (Bassia longifolia). This semi-solid oil noticed by Mr. Wilson, in the foot note to page 18, as Bassia butter,) is expressed from the seeds of a tree very common in Southern India. Though much used by the natives, who extract 30 per cent. of bright yellow oil from the seeds, it is seldom sold; candles and soap are made from it, but it is chiefly used as a substitute for butter in the native cookery, and for burning in their lamps.

4. *Cocoa-nut oil* (Cocos nucifera). Of this well-known oil the enormous average of 900,000 gallons has been annually exported from Madras during the last few years. The much largest proportion goes to Great Britain and France; the rest to Arabia, Mauritius, &c. The prices vary from 40*l.* to 50*l.* a ton, that called the Cochin oil fetching the higher sum. In Europe candles, soap, and the lubricating of machinery; in India cookery, lamps, medicine, and anointing the person; all are uses for which cocoa-nut oil is available.

5. *Bryonia oil* is burnt in lamps in parts of India where the plant abounds, but it is not extensively procurable.

6. *Ground-nut oil* (Arachis hypogæa) is a very valuable product. The plant is much cultivated throughout India: the poorer people eat the nut; and the oil, which fetches in London 47*l.* 10*s.* per ton in 1855, has been exported to the amount of 100,000 gallons a year. The demand, however, is fluctuating, sometimes not much exceeding half that quantity. Mr. Wilson (see the note p. 18,) testifies to the value of this oil.

7. *Poppy oil* (Papaver somniferum) is extracted from the seed wherever the poppy is grown for opium, and is sold at the rate of 40*l.* per ton.

8. *Mustard oil.* (Sinapis) Five or six species are cultivated throughout India for their valuable oil, which is much esteemed in the country for cookery, for medicine, and for anointing the person, but it is not at all exported. The seeds, however, are shipped, and to the amount of, (in 1848,) 5,000 cwts., rising to 16,000 cwts. in 1853.

9. *Gingeley* or *Sesamum oil* (Sesamum orientale) is even more used by the natives of India than cocoa-nut oil, and is second to none other in commercial value. The seed as well as the oil is largely exported: of the former upwards of 250,000 cwts., and of the oil 72,000 gallons, were exported in the year 1848 from

Lieutenant Hawke here introduces what he justly pronounces to be an excellent epitome of those particular

Madras. The United Kingdom and France were the chief recipients. The oil is chiefly used in India for cooking and for anointing the person; in England it is made into soap, and consumed in table lamps, being better suited to the latter purpose than cocoa-nut oil, because of the lower temperature at which it congeals. Its present value (1855) in this country is 47*l.* 10*s.* per ton.

The black-seeded Sesamum (a variety) affords a larger per-centage of oil than the red-seeded kind; but their produce is alike in quality. Sesamum seed has latterly been exported to France, and the present price is consequently double what it was three years ago.

10. *Ramtill oil* (from Guizotia oleifera and Verbesina sativa) is a sweet-tasted edible oil, plentiful in the Mysore, &c., and used for the same purposes as the Sesamum oil (Gingeley), but is not considered quite so good.

11. *Margoosa* or *Neem oil* (Azadirachta Indica and Melia Azadarach), a valuable oil, is much employed by native practitioners, administered both internally and externally; it is produced by the seeds of the above-mentioned trees, which are common throughout the Presidency. It is sold in the bazaars, for burning, under the name of Bitter oil, and is exported, though not constantly, to Ceylon.

12. *Lintseed oil* (Linum usitatissimum) is too well known to need description. The generally received opinion that Lintseed oil from India is inferior to the English raised article is due to its careless preparation. The quality is as good, and the quantity larger, when the same process is pursued in India as at home.

13. *Hemp-seed oil* (Cannabis sativa). Not generally used in India, though the plant is much cultivated.

14. *Ben oil* (Moringa pterygosperma). Valuable, because it does not soon turn rancid, and it might be procured in large quantities, as the tree is common throughout India; but though the flowers, foliage, and fruit are eaten by the natives, and the rasped root is used by Europeans as horse-radish, the oil is seldom extracted, and does not now form an article of export, except for watchmakers, who use none else.

15. *Portia-nut oil* (Thespesia populnea). A deep red coloured and thickish oil is extracted from the seeds of this tree, which is abundant throughout the Presidency, and is valued for its beautiful flowers, useful wood, and rapid growth. Its juice is serviceable in cutaneous complaints, and the oil has probably the same medicinal properties.

16. *Brumadundoo* or *Coorookoo oil* (Argemone Mexicana). A pale yellow clear oil, sometimes consumed in lamps by the natives, but doubtless available for more important uses. The plant was originally brought from Mexico in ballast, and it now flourishes luxuriantly throughout India.

17. *Safflower oil* (Carthamus tinctorius). The seeds of this well-known dyeing plant yield a light yellow clear oil, used for culinary and other purposes.

18. *Pinnecotay* or *Poonseed oil* (Calophyllum inophyllum). A dark green strong-scented oil is procured from the seeds: it is mainly used for medical purposes

19. *Soap-nut oil* (Sapindus emarginatus). A semi-solid oil, valued as medicine by the natives, but too costly to be generally employed.

20. *Poonga or Kurunj oil* (Dalbergia arborea). Chiefly used for adulterating lamp oil.

21. *Croton oil* (Croton Tiglium). A well-known medicine.

22. *Cashew-nut oil* (Anacardium occidentale). Equal, if not superior, as an edible, to olive or almond oil, and procured from the nut of this tree.

24. *Cashew-Apple oil* (A. occidentale). A powerful vesicatory, extracted from the pericarp of the same fruit.

25. *Belgaum Wallnut oil* (Aleurites triloba). The facility with which the oil is separable from the Lumbang nut, as this is often called, is noticed by Mr. Wilson as a recommendation. The fruit is also abundantly produced, and the nut yields a very large per-centage of oil. In the islands of the Pacific and elsewhere, it is

qualities whereon the commercial value of an oil depends, in the form of a letter, or printed circular, from G. F. Wilson, Esq. (alias Price and Co., and there can be no better

customary to thread the nuts on a thin strip of Bamboo, when they will burn like a candle.

26. *Poorana oil* (Sarcostigma Kleinii), said to be useful in the treatment of rheumatism.

27. *Piney* or *Doopada oil* (Vateria Indica). This highly valuable tree yields not merely oil, but a resin nearly equal to Copal, and an excellent timber. The oil is perfectly solid, even in hot countries, and is extracted by roasting and grinding, and boiling the seeds; it is chiefly used for lamps, but is also suitable for soap and candle-making.

28. *Wild Almond oil* (Terminalia Catappa). Little known.

29. *Neeradi-mootoo oil* or *Nebrada Mootoo*, a valuable oil, known under many names, and largely entering into native prescriptions. It may, probably, be found of service in the arts.

30 & 31. Glaucous-leaved *Physic-nut*, the produce of Jatropha glauca, and the *oil* extracted from the angular-leaved *Physic nut* (Curcas purgans), are used both medicinally and for lamps by the natives, but are little known beyond the districts where they are procured.

32. *Malkungunee oil* (Celastrus paniculata). The seeds of this shrub yield a deep scarlet medicinal oil by expression, and a black one (oleum nigrum). *See* No. 53.

33. *Fennel-flower oil* (Nigella sativa). A dark and fragrant oil is extracted from the black aromatic seeds of this plant.

34. *Cheeronjee oil* (Buchanania latifolia). The natives eat the kernels of this tree to make them fat; and they (rarely) extract the straw-coloured sweet and clear oil which abounds in the nut.

35 & 36. *Cucumber-seed* and *Melon-seed oils*, and (37) *pumpkin-seed oil*. Edible and clear.

38. *Nutmeg-butter* (Myristica moschata). An oil is obtainable by expression from the nutmeg, and retains the peculiar smell of that spice.

39. *Gamboge-butter* (Garcinia pictorum). This name is given to the solid oil which is contained in the seeds of the Gamboge tree, a species of *Garcinia* closely allied to that which produces the Cocum Butter. The oil is procurable in moderate quantities, by pounding and boiling the seed; it does not possess the drastic qualities of the Gamboge resin, but is valued as an antiscorbutic ingredient in food.

40. *Marking-nut oil* (Semecarpus Anacardium). The acrid and vesicating oil, which is contained between the laminæ of the pericarp of the *Marking-nut*, is used as a preventative against the attack of white ants, and by native practitioners as a remedy in rheumatic and leprous affections.

41. *Bonduc-nut oil* (Guilandina Bonduc), considered useful in palsy and convulsions.

42. *Mahowa oil* (Bassia latifolia). Different samples of this so-called oil would seem to be derived from a different tree or trees, some being solid and others quite fluid.

43. *Sterculia oil* (Sterculia fœtida). This semi-solid oil appears to contain a large quantity of Stearine; but may not be obtainable in sufficient quantities to deserve attention in a commercial view.

44. *Moodooga Oil* (Butea frondosa). Procured in small quantity and used medicinally.

45. *Mimusops Oil* (Mimusops Elengi). Medicinal, and obtainable in tolerably large quantities.

46. *Nux Vomica Oil* (Strychnos Nux Vomica). Empyreumatic, and used medicinally.

47. *Wild Cumin-seed Oil* (Vernonia anthelmintica). Nothing known respecting the specimens of this oil.

48. *Garlic Oil* (Allium sativum). Medicinal.

49 & 50. *Oils* from *Radish Seed and Cabbage seed.*

Sir W. Hooker on Vegetable Products.

India, &c.

authority) addressed to Sir William Hooker, which is here transferred to a note.*

51 & 52. *Cardamoms* and *Colocynth seed oils.* Well known.

53. *Oleum nigrum* (Celastrus paniculata). An empyreumatic oil, obtained by the destructive distillation of the seeds. (*See* No. 32.)

In summing up the qualities of the above-mentioned oils, it may be said that the best seem to be the *Poppy, Brumalundoo, Karunj, Belgaum Wallnut* (also called *Lumbang Nut*), *Poorana, Neeradi-mootoo*, and *Physic-nut Oils*, and the *Gamboge Butter.*

The following List of other Fixed Oils completes the produce of the Madras Presidency :—

Sunflower Oil.	Gutta Percha Seed Oil.
Thorny Trichilia.	Saul Seed Oil.
Cyperus Oil.	Eugenia Oil.
Cotton-seed Oil.	Dammer Tree Oil.
Thorn-apple Oil (empyreumatic.)	Kikuel or Salvadora Persica Oil.
Coccum Butter.	Coccus Indicus Oil.
Fænugreek Oil.	Limbolee, or Bergera Kœnigii Oil.
Condamunnee Oil.	Balanites Ægyptiaca Oil.
Adenanthera Pavonina Seed Oil.	Hyoscyamus Oil.

Except the Cotton-seed and Sunflower (and Coccum.) Oils, most of the oils in the foregoing List are only procurable in very small quantities, and are chiefly used for medicine.

* "Every oil or grease, whether solid or liquid (unless it be poisonous and acrid like croton-oil, or viscid and gummy like castor-oil, or drying like lint-seed oil, must be worth, in London, at least 30*l.* per ton. Among greases, solid at above 60 degrees of Fahrenheit, the higher the melting-point the greater (other things being equal) is their value; for example. the Vegetable Tallow of Borneo, melting at about 90° Fahrenheit, is worth at least 5*l.* a ton more than the cocoa-nut oil of Ceylon, which melts at 70°.

The soap duty being taken off may soon much change the relative value of greases; but at present liquid oils, as that of the *Ground Nut* (Arachis hypogæa) are worth more than soft solid oils, like the *Bassia butter* of India, because they require less manufacturing to fit them for use; the liquid oils, after a simple treatment in a cheap apparatus, being ready for burning in lamps; while the soft solid oils, which are neither hard enough for candles nor fluid enough for lamps, require to go through a press before they are saleable, except for soap-making. Greases may possess particular advantages, as being little acted upon by the air, and therefore not easily turning rancid. But these good qualities can only be ascertained by experiments, which had perhaps better be left to practical chemists like ourselves.

We have been experimenting upon oils with a view to medicine, in which it seems likely they may take an important place. Already one Vegetable Oil has proved to be nearly as efficacious as cod-liver oil, with the advantage of being less unpalateable and cheaper. This new useful oil would suggest the desirableness of collecting oils in small quantities, even if they do not fulfil the conditions which I have already mentioned.

Again, the value of the oil must somewhat depend (especially when found in remote spots) on the way in which it is held in the matrix; for instance, the oil of the *Lumbang Nut* (Aleurites triloba) is separable with much less labour and simple machinery than cocoa-nut oil, which demands a strong pressure to extract it from the dried kernel.

Waxes are worth more than greases, because of their very high melting points. Their relative value depends upon colour, transparency, and freedom from resinous matter. Resin may be easily detected by kindling a small portion of the wax; the more smoke escapes the greater is the proportion of resin and the less valuable is the wax. The palest and most transparent wax is the best. No Tree wax is so valuable as the beautiful *Insect Wax* from China.

A simple way of trying an Oil-Nut is to crush it with a stone, and then squeeze it between the finger and thumb. If it contains any considerable quan-

Wood Oils.

Mostly obtained from Chittagong, Arracan, and the Straits, and in general procured by tapping certain Dipterocarpous and other Trees and applying heat to the incision. The oil which flows out has the nature of a Balsam and a Volatile Oil, and when used as a varnish the oil evaporates, and deposits a durable coat of resin.

Wood-oils are chiefly employed as natural varnishes, or as a substitute for Tar, or to preserve timber from the white ants. They are said to form an useful ingredient in Lithographic Inks.

It is to be regretted, that owing to distance and our imperfect knowledge of the countries whence they come, these oils cannot be traced with certainty to their botanical sources; and their names are therefore vaguely applied, and generally are only indicative of the localities whence we receive them. Though differing in colour and consistency, and obtained from widely different plants, all have the peculiar balsamic odour of the *Dipterocarpeæ*.

The principal are as follows:—

Teak Wood Oil, so called, is opaque and dull ash-coloured, and is mainly used for wood-work, either as a simple varnish or combined with resin.

Wood-oil, from *Pegu*, is a very clear and fluid natural varnish.

Deodar or *Shemanuthee* oil is the produce of Erythroxylum areolatum: it is empyreumatic and medicinal.

Wood-oil from *Chittagong*. Little different from the Teak and Pegu wood oils.

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tity of grease, enough will be pressed out to judge of its colour, hardness, and sweetness. If the nut tastes oily, but does not give out oil under the above treatment, it is well to dry the kernel before squeezing it; and in the case of nuts containing a grease which is solid at a high temperature, like that of *Myristica sebifera*, it is desirable to heat the nut and to proceed as follows:—Get, if possible, a stearic candle, burn it down a little till it has formed a cavity, then blow out the candle, and place a small quantity of the material to be tested in the hollow; relight the candle, and after a moment's burning the candle material with which the wick was saturated will be consumed, and the new substance from the cavity takes its place, and becomes the material which supplies the wick till it is exhausted, and can thus be judged. Or a piece of string dipt in the oil or melted grease makes a very tolerable wick. Or, simpler still, the nut itself, if very full of oil, may be lighted at one end, and it will at least show whether it gives out smoke and what is the colour of the light.

Some of the Resins ought to be available for manufacturing candles, though their tendency to cause smoke has hitherto confined their use to the commonest kind of candles. As resins differ, however, in this respect, we may hope that some may yet be found adapted for candles.

The points connected with new greases, &c., on which we chiefly desire information are these:—manner of growth, expense of collecting, means of transport, and the probable quantity to be obtained. Small samples of the grease, if manufactured, should be sent, and specimen of the fruit, with both its husk and hard shell (where they exist.)"

Sir W. Hooker on Vegetable Products. India, &c.

Wood-oil from *Moulmein* and *Singapore*. Mr. Hanbury, (*Pharmaceutical Journal*, Jan. 1856,) states that a *Wood-oil* is now extensively imported into London from Moulmein, and sold under the name of *Balsam Capivi*.

Wood-oil from *Rangoon*. Of peculiar appearance, white, and almost solid, but with the same resinous odour as the other Wood oils.

Wood-oil from *China*. A valuable product, being the principal ingredient of which the well-known China Lacquer is made. It is used at Singapore for painting the beams of the native houses, but it does not bear much exposure to the sun.

Sissoo Wood-oil (Dalbergia Sissoo). Empyreumatic and medicinal.

Wood-oil from *Tinnevelly*. Resembling Tar, chiefly used by native medical practitioners.

Camphor Wood-oil (Dryobalanops Camphora). Extensively used at Singapore as a substitute for Turpentine.

A very interesting specimen of *Wood oil* closes the set. It comes from Malacca, where it is the unprepared product of a very large and common Dipterocarpous Tree, which, if not too soon tapped, attains an immense girth. The wood is reddish-brown, with a smell like an English Fir; the leaves are alternate, pinnated, and exstipuled, the fruit a one-seeded drupe; the seed angular and inverse.

Volatile Oils.

Volatile Oils and Aromatic Substances.*

Under this head, Dr. Royle's collection enumerates:

Various Bottles of Essences, not particularized;
Melaleuca Cajeputi;
Andropogon Calamus-aromaticus;
Rosa sp.;
Jasminum sp.;
Pandanus odoratissimus;
Nyctanthes Arbor-tristis;
Santalum album.

(The last four, it must be observed, are usually called Attars or Essential Oils in India, and are fatty oils impregnated with some of the Volatile oils of the Plant.)

* Lieut. Hawke, in his Report on the Oils of the Madras Exhibition, 1855, observes that, of vegetable substances producing volatile Oils, there is an immense variety in India; but, with the exception of the Oils of Cassia and Cinnamon, Roosa (as the perfume extracted from the sweet smelling Grass, Andropogon Calamus aromaticus, is called in India, Vitivert is its name among British Perfumers), and Rose Attar, few are of commercial importance, or are prepared in any quantity. Scented Oils, erroneously termed Volatile, and obtained by repeated distillation of fragrant herbs over and into a receiver containing fixed Oil, to which the aroma is imparted, are prepared to some extent, but chiefly for native use.

Sandal-wood Oil, and the numerous attars employed in native perfumery, are included in the above class of articles.

6. Gums and Resins.

Gums.

These may conveniently be divided into two series, viz., Simple Gums, and Resins and Gum-Resins (including Varnishes).

Simple Gums,

(Or such natural exudations as solidify by exposure to the air, but are easily dissolved by water.)

Gum Babool (Acacia Arabica).
Gum Gattee (A. Arabica).
Gum Kuteera (Cochlospermum Gossypium).
Gum Keekur (Vachellia Farnesiana).
Gum Margosa (Azadirachta Indica).
Gum Ballee (Sterculia urens) and *Sterculia ramosa.*
Gum of Feronia Elephantum.
Soap nuts (Sapindus detergens.)
Gamboge from Siam (Garciniæ sp.).
Gamboge from Mysore (G. pictorum).
Katteemundoo (Euphorbia Kattimandu.)*

Resins and Gum-resins,

(Such exudations as are insoluble in water, but soluble in alcohol.)

Under this head, comes an extensive Catalogue; among them, are:—

Shorea robusta.
Vatica Tumbagaia.
"*Sarcocolla.*"
Cedrus Deodara.

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* Dr. Cleghorn, the able reporter on the Gums and Resins of the Madras Exhibition, says that the only true Gum which in that Presidency enters largely into commerce is the *Gum Arabic* or *Babool Gum*; but he notices more or less particularly the following:—

Wood-apple Gum, obtained from Feronia Elephantum, useful especially for making Ink.

Keekur Gum, produced by Vachellia Farnesiana (a variety of Gum Arabic).

Dirisana Gum, the abundant exudation of Acacia Sirissa. Very like the foregoing.

Kut or *Kheir Gum,* a watery extract from Acacia Catechu. Sent from Canara in cakes or balls covered with Paddy husk.

Cashew Gum (Anacardium occidentale). Transparent, and a good preservative against insects.

Moringa Gum (Moringa pterygosperma). An abundant exudation; allied to Gum Tragacanth.

Booraga Gum (Bombax Malabaricum). Very pure.

Gambir (Uncaria Gambir). In cubical cakes.

Butea Gum (Butea frondosa). Astringent; and procurable in large quantities.

Vutta Thamary Gum. Origin not positively known. The gum is pure, and of a light crimson colour, and has been used for taking impressions of leaves, coins, &c.

Vateria Indica (Pinay).
Dipterocarpus (Dhoona).
Canarium strictum and *C. glabrum.*
Embryopteris glutinifera.
Terminalia angustifolia.
Boswellia floribunda and *B. thurifera.*
Balsamodendron Myrrha and *B. commiphora.*
Balsamodendron Mukul, B. Gileadense, and *B. Agallocha.*
Ailanthus Malabarica.
Pistacia Terebinthus and *P. Lentiscus.*
Pinus longifolia.
Coccus lacciferus (produced by several plants.)
Assafœtida or *Narthex Assafœtida.*
Galbanum officinale.
Butea frondosa.
Styrax Benzoin and *S. officinale.*
Dorema Ammoniacum.
Garcinia pictorum, and other species.
Euphorbia Antiquorum.
Dragon's blood, or *Dracæna Draco.*
Aloe Soccotrina.
Buchanania latifolia.
Andersonia sp. (Dhas Gum).
Odina Wodiei.
*Diospyros tomentosa.**

* The following are extracted from Dr. Cleghorn's notes, in continuation of his List of Resins and Gum-resins:—

Doopada Resin (Vateria Indica). It constitutes the Piney varnish, and is much used for incense.

Dikamali Resin (Gardenia lucida). Useful in Hospitals and in Farriery, from its powerful aroma.

Assafœtida (Narthex Assafœtida). Well known (from the Persian Gulf).

Bdellium (Amyris Commiphora). Both solid Gum and Balsamic fluid are produced by this tree.

Gamboge (Garcinia pictorum). From Malacca (the best), in pipes; from Mysore in lumps; in tears from Labuan; the produce, probably, of Garcinia Cochin-chinensis.

Coorg Resin (the tree unknown) is green, semi-transparent, hard, and promises to be useful.

Bababooden Resin (from a Dipterocarpous tree): fragrant.

Mutty Pal (Ailanthus Malabaricus), a resinous exudation, used for incense.

Lac, a substance produced by the punctures of Insects on various trees, as Vatica laccifera, Croton lacciferum, Erythrina Indica, &c., also on Schleichera trijuga, which last is the best. Lac is a colouring resin, abundant in the South Indian Jungles, but it is not of much importance in commerce.

Gum Elastics.—Among this Class of Gums, Dr. Cleghorn directs attention to some interesting novelties, premising that the rapid failure of the Gutta Percha from the Indian Archipelago, and the increasing adulteration of India-rubber and Caoutchouc, alike give importance to any new Gum Elastic which may promise to supersede them, and he proceeds to enumerate the little known kinds which were exhibited at Madras; namely,

Panchonthee, which is the product of a large Saponaceous forest-tree from Trevandram, and which much resembles Gutta Percha both in appearance and qualities.

A second *Gum Elastic* of a similar kind, from the Neilgherries, where the trees abound.

A third, called *Cattimundoo Gum,* which is used, when freshly exuded, as a vesicant, and also as a cement for fastening knife-handles, &c. Two cwts. have been sent to London for experiments.

Euphorbia Tirucalli yields a Gum much like the Cattimundoo Gum.

7. Medicinal Substances.

Medicinal substances (little worthy of remark).

Under the head of medicinal substances in common use in India, we find a long catalogue; and as there appears to be nothing new, or peculiarly worthy of remark, among them, and as indeed, most of them are either cultivated or imported, I shall confine myself to the bare list. I presume it must be owing to some strange oversight, that these substances are entirely omitted in the "Catalogue" of the British Section of the Exhibition: many of them, however, which come under the head of Medicines, have been already noticed under other vegetable products.

Styrax Benzoin.
— acidum Benzoin.
Cocculus cordifolius.
Berberis Lycium.
Celastrus nutans.
Helicteres Isora.
Bombax Malabaricum.
Acorus Calamus.
Zingiber Cassumunar.
Gardenia sp.
Dracocephalum Royleanum.
Randia dumetorum.
Cochlospermum Gossypium.
Xanthoxylum Budrunga.
Wrightia antidysenterica.
Agathotes Chirayta.
Ipomœa Turpethum, and *I. cœrulea.*
Rheum Emodi.
Aucklandia Costus-verus.
Croton Tiglium.
Piper longum.
Aloe (of India.)
Asparagus adscendens.
Strychnos Nux Vomica.
Guilandina Bonduc.
Garcinia pictorum (Indian Gamboge).
Anamirta Cocculus.
Papaver somniferum.
Sinapis glauca.
Coptis Teeta.
Ægle Marmelos.
Xanthoxylum hastile.
Balsamodendron Myrrha, B. Mukul, and B. Commiphora.
Tamarindus Indica.
Cassia Fistula.
Pterocarpus Marsupium.
Cydonia vulgaris.
Melaleuca Cajeputi.
Punica Granatum.
Narthex Assafœtida.
Dorema Ammoniacum.
Cuminum Cyminum.
Nauclea Gambir.
Anacyclus Pyrethrum.
Cucumis Pseudo-Colocynthus.
Soymida febrifuga.
Plumbago Zeylanica.
Calotropis gigantea.
Hemidesmus Indicus.

E. neriifolia produces a similar substance.

Cryptostegia grandiflora. This strong and handsome climbing plant abounds on the Eastern coast of India, and its milky juice contains caoutchouc, which is of excellent quality, and may be an article of importance if it can be obtained in sufficient quantity.

A remarkably fine specimen of *Sheet India rubber*, weighing about 2 lbs. closes the List of Gums, &c. exhibited at Madras.

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India, &c.

Aconitum ferox.
Quercus infectoria.
Cannabis sativa (Ganja.)
Cassia officinalis.
Acacia Catechu.
Ricinus communis.
Hymenodictyon utile.
Tylophora vomitoria.
Hedychium spicatum.
Taxus baccata.
Datura alba.
Barringtonia acutangula.
Justicia paniculata.
Clitoria Ternatea.
Melia Azadirachta.
Cordia Myxa.
Embelia robusta.
Strychnos Potatorum.
Adiantum lunulatum.
Pterospermum acerifolium.
Semecarpus Anacardium.
Picrorhiza Kurrooa.
*Cubeba officinalis.**

8. Spices, Pulses, and Cerealia.

The above are so entirely the results of cultivation, so cosmopolitan, in fact, that I deem it better to omit them altogether.

Besides the Grand Medaille d'Honneur awarded to the East India Company a Grand Medaille d'Honneur was awarded to Dr. Royle for his services in this and other classes of the Exhibition as co-operator, and to Mrs. Royle for her zealous and useful exertions as co-operator in Class II.

Honorary mention to Mr. W. E. Underwood, for fibres of various plants.

Algeria.

II.—ALGERIA.

(Minister of War, Direction of Algerian affairs.)

Algerian Collection; highly important.

The second collection which I propose to consider, is from Algeria. It ranks among the very first in the Paris Exhibition, whether as regards the extent and variety of its Vegetable Productions, or the amount of scientific knowledge which has been brought to bear on its arrangement and

* Dr. Cleghorn, in his Report on the Chemical and Pharmaceutical Processes and Products generally of the Madras Exhibition, is very brief on the subject of the Medical Substances, but says that Southern India abounds with simple, energetic, and appropriate remedies adapted for treating Tropical Diseases. He and his brother Jurors are of opinion that "many indigenous drugs, besides the country medicines, might be brought into use and improved by Pharmaceutical operations." The few additional ones that are noticed appear to be of trifling value till their properties are more perfectly tested; and comparatively few medical Vegetable products are exported exclusively as such from the Madras Territories. The following List is given for 1854:—

	Quantity.	Value.
Catechu	1,369 cwts.	6,984 rupees.
Kino	66 „	1,031 „
Country Sarsaparilla (Hemidesmus Indicus)	269 „	1,699 „
Senna	404 „	2,817 „

elucidation. Algeria possesses, too, this peculiar claim, that while continental India has been inhabited by Europeans for centuries, and its productions were, to a certain extent, known by the intelligent natives before the white man set foot on its shores, the country now under special review is a possession new to the more civilized and intellectual portion of mankind, and an acquaintance with its resources has suddenly opened on our view. No fuller proof of this fact can be adduced than the simple circumstance that the majestic Cedar, that most conspicuous and unmistakeable denizen of the forest, was not known, till about 20 years ago, to grow in Algeria.

SIR W. HOOKER ON VEGETABLE PRODUCTS — ALGERIA.

Vegetation only recently known;

The territory of Algeria occupies in Northern Africa an area of 700 miles from east to west, and is of very indefinite extent from north to south, for it gradually merges into the domain of the free mountain tribes, its southern limits being traversed by ranges of the Atlas mountains. The whole is divided into three provinces,—Algiers, Oran, and Constantine. A great portion of the country is of striking natural fertility; yet the indolence of the people, the oppression of the native governments, the absence of roads and of all means of internal communication, caused three-fourths of the land to remain uncultivated till it was subjugated by the French in 1830. Now, Europe is astonished at the extent of the products here shown, and at the resources of the colony as thereby proved. The arrangement of the collection is worthy of its contents. The ground floor of the *Annexe* exhibits chiefly the raw products; and one is surprised to see assembled, from a country of such comparatively small extent, the plants and fruits of the tropics and of temperate climates, and all of the finest kinds. Oranges, lemons, citrons, cedrats, dates, cherimolias, bananas, arachis, &c., are mingled with almonds, chestnuts, figs, sweet acorns (from the Quercus Ballota), pomegranates, olives, grapes, apples, &c.; and the finest maize, rice, sorghum, millet, along with wheat, barley, oats, and rye that would do honour to the best arable district in the north of France or in England. Yams, batatas, eddoes (Caladium esculentum), are ranged by the side of potatos as good as our Sister Isle could boast, and cottons are mingled with hemp and flax. Vast collections of useful woods, in their rough state and manufactured, and fibres in every stage of preparation, from the plant itself to these rich fabrics which attract public attention in the glazed cases of the gallery above. Such are some of the Algerian Vegetable Productions.

advantages of climate;

It must not, however, be supposed, that a collection of such size and value was suddenly and exclusively prepared for the Paris Exhibition; the French Government had already

Interest excited by the subject,

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Algeria.

established a permanent Algerian museum, and fixed it in Paris. It was originally, as is stated in the Preface to the Catalogue, "but a humble collection of specimens deposited "in a department of the War Office, for the instruction of "the *employés* there, and of some few curious visitors. After "the London Exhibition, which brought to light and proved, "at home and abroad, the native wealth of Algeria, this col- "lection was located and re-arranged in a private house in "the Rue de Bourgogne. From that day, when it was opened "to the public, it gradually increased in popularity; and being "rapidly augmented by private donations, and by those of the "Algerian Government, it quickly overflowed its too narrow "limits. Marshal Le Vaillant, Minister of War, was anxious "to obtain for this museum of agriculture and industry a "position, worthy of its present valuable contents and of the "rising Colony's next to unbounded resources; and now, "deposited in the halls devoted to the Algerian Exhibition, "and placed under the most favourable conditions of space "and of light, it fulfils perfectly its double object, as a witness "to the Present and a warrant for the Future."

in Paris, &c.;

Here I must confine myself chiefly to "*Produce obtained without cultivation*," and am happy in the great assistance rendered by the Printed Catalogue, which, though late in appearing, is applicable both to the present *Exposition Universelle* under consideration, and to the permanent disposition of the collection in Paris. It is entitled "Catalogue expli- "catif et raisonné de l'Exposition permanente des Produits "de l'Algérie (Rue de Grenelle, Saint Germain, 107,) suivi "du Catalogue méthodique des Produits Algériens à l'Ex- "position Universelle de Paris, 1855; Ministère de la Guerre. "Direction des Affaires de l'Algérie." It is indeed as valuable of its kind as is the collection of which it is a catalogue, communicating, as every such illustrative guide should do, information, derived from experience, relative to the history, statistics, commercial value, uses, applications, &c. of the various objects; every kind of wood and fibre and each economic product being briefly described; while, throughout, the correct scientific names, when they could be obtained, and the local ones, are recorded.

The catalogue well done.

1. Fibres.

Algerian Fibres.

Though the plants here enumerated as yielding useful fibres be few in number, many of them are curious and little known. It must also be remembered, that in a young colony, attention is first and mainly directed towards those kinds of which the commercial value is already established, as cotton, hemp, and flax, and these being invariably cultivated

plants, do not belong to the class which I am called upon to consider. Those which require to be noticed here are wild plants, or such as have become thoroughly naturalized, and they are primarily enumerated according to their respective industrial uses, as—

1. For building purposes (owing to the stoutness of the stem and tenacity of the fibre, and which may almost fall under the denomination of woods): such are the Date, Palm, Bamboo, Agave.

2. For furnishing ("ameublement"): Cactus, Bamboo, Calabashes.

3. For veneering: Bamboo, Date, Palm, Cactus.

4. For platting: Rushes, Alfa (Lygeum Spartum, &c.) Dis, (Festuca patula,) &c., Dwarf Palm, Date Palm.

5. For cordage: Alfa, Dis, Dwarf Palm, Agave, Yucca, Banana, Date Palm.

6. For saddlery, carpeting, fabrication of Vegetable Horsehair or bristles (crin végétal): Dwarf Palm, Alfa, and Dis.

7. For paper-making (fabrication of Pulp for Paper and Pasteboard), Alfa, Dis, Dwarf Palm, Agave, Banana.

8. For garments (besides Hemp, Flax, and Cotton): Phormium (the New Zealand Flax), Jute (corète), Abutilon, the White Nettle (Urtica or Boehmeria nivea).

9. In turnery: Dwarf Palm (the seeds).

These again are more fully treated of under two heads.

1. *Plants with woody fibres.*

Opuntia vulgaris, or Barbary Fig, the fibre of.

Barbary Fig (Opuntia vulgaris, Mill.) Among the most remarkable of the woody fibres, and the uses to which they are applicable, is that of the great Cactus or Opuntia (O. Tuna, I believe, but here called O. vulgaris,* Mill.) A huge "trunk, eight or ten feet long and many inches thick, divested "of the outer coat and pulpy substance, exhibits a most "curious network of woody fibres," which may be turned, as M. Toussaint has found, to a useful account. He observes that "in every leaf and joint of the stem, a new "layer of these woody fibres is annually deposited, and that "the nerves cross, interlace, and mingle, like the threads of

* If the account be perfectly correct, it is important to determine the precise species of which the author of the catalogue says that the "Algerian Cactus" singly serves all the requirements of the "nouvelle Industrie." The writer must surely be aware that all the four kinds of *Cactus* and *Opuntia* come from the New World: none is indigenous to Africa. The *Opuntia vulgaris* (Mill.) is considered by all recent Botanists to be the *Cactus Opuntia* of Linnæus (figured and described in Curtis's Botanical Magazine, tab. 2393), and which is a small succulent plant, very common in our greenhouses. The samples in the Exhibition are of a kind forming erect woody stems, many (20 or more) feet high, quite resembling *O. Tuna.*

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"lace, the thinnest being inside and very delicate, the stoutest "next the outer bark and attaining considerable strength." M. Toussaint asserts that "the other species of *Cactus* (or "*Opuntia*), C. inermis, coccinellifer, and Tuna (?), which "nourish the precious cochineal insect, are too abundant "in watery juice to produce much fibre; and that the "species, which in Mexico attains an height of 10 mètres "(60 feet) loses in strength what it gains in stature. The "woody fibre of the plant is capable of forming many orna-"mental objects; it combines with gold, silver, and copper: "it harmonizes with rose-wood, &c., or with leather, and may "be bleached by chlorate of lime to a perfect whiteness, and "tinged of all the colours which other textile substances "receive. It is easily worked, for the layers separate with "facility, and serve for veneering tables, or for covering books "and boxes, while combined, they may be moulded by steep-"ing in hot water, into work-baskets, flower-trays, &c." M. Toussaint's praise of this substance is borne out by the many handsome articles in the Exhibition made of *Cactus* fibre, the most conspicuous of which are two large vases, of good form, but which might have looked better without the extraneous ornament bestowed upon them. The Museum of the Royal Gardens of Kew is in possession of some interesting articles in this material, prepared by and purchased of, M. Toussaint.

Gourds and Calabashes can hardly, I think, come under the category of fibres: the husk of the dried fruit is employed for various domestic purposes, because of its hard woody nature.

Date Palm, its general utility and fibre.

Date Palm (Phœnix dactylifera). Of the rachis or stalk of the leaf, called by the natives Djerid, (whence the country is named *Beled el Djerid*, or the Land of Date Palms,) the shafts of lances are made. In the *Bride of Abydos* and the *Giaour*, Lord Byron mentions "the swift Djerid," or Djerreed. (Other English writers spell the word *jerreed*.) Europeans use this stalk for the more pacific purpose of a walking-cane, which it serves excellently. Mats, fans, cushions, and broad-brimmed hats are woven of the fibres which abound in the foliage. The reticulated tissue, which surrounds the base of the leaf-stalk, is used to stuff the camels' harness and to make ropes, and it affords excellent gun-wadding; the stalk on which the dates grow, when stript of the fruit, serves for brooms, and the weaker ones are applied to weaving baskets, &c.

Bamboo (Bambusa arundinacea, *Retz*), originally from India and China, is now naturalized in Algeria, having been first reared there in the Central Nursery; the colonists have

diffused it all over the country. It serves to bind firmly the banks of streams and edges of dykes, wherever the soil is not too dry for its growth; its stems, which attain their proper firmness in two years from the time of shooting, are serviceable for hop-poles and supports for vines and climbing plants, while the weakest are useful for trellises, &c.

France imported, during 1853, Bamboos and strong Reeds to the value of 104,000 francs from various countries.

Beautiful samples of Bamboo, naturalized in Algeria, are exhibited, together with a remarkable shoot, of only six months growth, cut in four lengths.

2. *Plants with textile fibres.*

Textile Plants.

Rushes (Joncs). These are probably some species of *Juncus*, but from an epithet which follows, it would seem that reeds (roseaux) are included. Rushes (les joncs) are sufficiently common in Algeria to give a name to some of the rivers; the natives use them for various kinds of platting, and have done so from ancient times, for the baskets and mats of Algiers, in which perhaps were combined the Alfa, or Halfa, (see what follows,) and parts of the Palms (mentioned before), were known as articles of export during the middle ages.

France imported Rushes and European Reeds in 1853, worth nearly 5,000 francs.

Halfa or *Alfa*. These are the Moorish names for certain Grasses, possessing very strong and tenacious fibres, such as Lygeum Spartum, Stipa tenacissima, S. gigantea, and S. barbata, all growing profusely in Algeria, alike in shade and sun, on rock and sand. Few plants are so valuable, as affording materials for innumerable fabrics and articles of industry. Baskets, matting, hats, shoes, bags, admirable ropes, and many other things are made of the fibres. The whole coast-line of Oran is fertile in *Alfa*. European invention has discovered in the waste part of the leaves a material for paper-stuff; the substance is deprived of its resinous matter, crushed and bleached, and then presents a kind of paste, which may be made of different degrees of fineness, and which, mixed with rags, gives consistency to the pulp and acquires the needful softness for paper-stuff.

France imported in 1853 the rough stems of *Spartum* to the value of 206,000 francs.

Dis (*Festuca patula*, or Arundo festucoides, Desf.) is a very common Algerian grass, and used like the *Alfa*, for platting and for ropes, as well as to feed cattle.

The basket-work made of Alfa, and exhibited, was in great variety, and very beautiful, both in texture and ma-

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nipulation, and so eagerly purchased by visitors that all the articles (and they were marked at very moderate prices) were quickly cleared off.

Algeria.

Vegetable Horse-hair from Dwarf Palm: its use,

Dwarf Palm (Chamærops humilis, L.) Besides the well-known textile properties of this Palm, a very important discovery in connexion with it has been made and patented by Messrs. Averseng and Co., of Toulouse, under the name of "African or Vegetable Horse-hair." The profusion with which the *Dwarf* or *Fan Palm* (called *Palmetto* in Spain and Italy) grows in Northern Africa, its comparative worthlessness, and hitherto the extreme difficulty of extirpating it, are all so many additional advantages to the ingenious patentee. It has long proved, by the depth, the strength, and the inextricable network of its roots, the plague and scourge of Algerian cultivators. The cost of clearing a "hectare" ($2\frac{1}{2}$ acres) of land which is covered with the Dwarf Palm, amounts to three or four hundred francs, and this outlay is but very slenderly reimbursed by the worth of the roots and wood for fuel and for charcoal. Large rewards have been offered for its extirpation; though the natives persist in making the material for their tents of its foliage and stems, mixed with camel's hair and wool, and applying it generally to the same purposes as the *Alfa* and the *Dis*. It must be confessed that the fibre of the Dwarf Palm is rather the best of the three. It also serves for spinning fine thread, which is of long staple and very strong. But the recent invention of Vegetable Wool, or African Horse-hair, promises to render the Dwarf Palm subservient to far more useful purposes than any hitherto discovered. The objections to wool and horsehair for mattrasses and stuffing for seats, &c. have long been felt. The Agave, the Zostera, have been tried, the latter with peculiar success, as substitutes. But the fibre of the palm possesses many and peculiar advantages; it is scentless, durable, supple, yet not too elastic; it may be carded twice or thrice without splitting, and with hardly any waste or dust. It is already advantageously employed for stuffing carriages, &c.; and it is undeniably much to be preferred to the mixture of horse-hair and "fob" (technically so termed) which upholsterers and carriage-builders now use for padding the cheaper kinds of vehicles.

and price.

Messrs. Averseng sell their *Patent Vegetable Hair* or *Wool* at half the price of hog's bristles, and 75 per cent. cheaper than horse-hair, over which it has the additional recommendation of not being liable to the attacks of the moth. A great number of coach-makers, upholsterers, and tailors bear testimony to its value; and its increasing sale proves that it is beginning to be known and appreciated.

Twisted fibres and the carded foliage were exhibited in numerous specimens, also an extensive suite of samples of the different products of the Dwarf Palm leaves, including *Vegetable Horse-hair*, black, and of the natural colour.

Banana (Musa Paradisiaca), i stalk usef for paper.

Banana (Musa Paradisiaca, L.) Paper, made from the fibres of the otherwise useless fruit-stalk of the Banana, which used to be thrown away when the fruit was culled, promises to be of good quality. The following testimony in its favour is given by MM. Peligot and Chevreul, in the name of the Academy of Sciences. The waste in the *Banana* is eleven per cent; whereas that upon rags is from twenty-five to thirty-three per cent, and sometimes even more. The paper, manufactured from the former in our presence, is of undeniably good quality, and takes ink well. It is not so white as might be if the chlorate had been longer (than three hours) used. It seems undeniable that excellent paper may be made from the fibre of *Banana;* and all depends upon the price at which it will be sold.

Paper and rope made from Musa textilis.

Abaca (Musa textilis). I am glad to find that this plant, which was formerly scarcely known beyond Manilla, is now introduced into Algeria. Its fibre is believed to be the famous *Manilla Hemp*, which the United States certainly import to an enormous amount, and make of it their cordage and paper. They also manufacture an admirable stout paper from the old and refuse ropes and cables, which far excels the "brown paper" of our own country in quality, and is of the same colour. The exquisite and well-known Manilla scarfs are made, according to many travellers, from the beautiful fibre of this same *Musa textilis*. Other writers allege that they are manufactured of Pine-apple fibre; and it must be confessed that doubt still exists as to which, or what, plant affords this delicate substance. There is good reason to hope that the Algerian colonists will decide this point by testing the produce of the *Abaca*, which, at present only exists in the Central Nursery, or Experimental Ground, where such trees and plants as promise to be useful in the colony are carefully reared for diffusion. Our own Navy uses Manilla Hemp for manufacturing ropes. The little we know with certainty as to the plant which yields this hemp is from dried specimens, which appear to be the original or wild Banana, of which the fruit is not eatable, but which bears seed, and the fibre of which is far more valuable than that of the cultivated Banana or Plantain.

Agave (Agave Americana, L.), is happily here designated by its correct name, whereas it passes in most colonies for an Aloe, or American Aloe, different though it is from the true Aloes, which are exclusively natives of the Old World.

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From the leaves a thread is obtained in Algeria, it is silky and strong, and well adapted for whip-lashes, string, nets, &c., and for all the purposes to which the *Alfa* and *Spartum* are applied. Like the Dwarf Palm it affords an excellent paper-stuff, and its pithy stem is preferable to cork for the insect boxes used by naturalists.

Three other species of *Agave* are under cultivation at Algiers, for experiments; A. fœtida, A. ferox, and A. yuccæfolia. The fibres of all are exhibited.

Yucca, or *Adam's Needle*, seems quite naturalized in Algeria. A colonist has extracted a beautiful white satiny thread from its leaves, which he considers stronger than Hemp, yet lighter and capable of finer subdivision. According to this grower's calculation, each stem of the *Yucca* bears 250 leaves at least, which multiplied by 4,300, the number of stems that a hectare ($2\frac{1}{2}$ acres) of land produces on an average, gives a growth of upwards of a million of leaves; their fibre is worth, at a round sum, 2,700 francs. He has patented his mode of extracting the fibre.

White Nettle (Urtica or Boehmeria nivea). A well-known Chinese fibre, of immense value and importance to that country. The fibre is reckoned the very best for calicos and muslins, and is used all over India; but "as tried" (though on a small scale) "in Algiers, the results have not been very satisfactory."

Hemp, Flax, and Cotton I purposely omit. The latter, however, has already been brought to very high perfection, and has attracted great attention among the growers and manufacturers of cotton.

Several textile plants.

Corète textile (Corchorus textilis). Under this name are exhibited the fibres of a plant said to be cultivated with great success, in China on account of its textile fibre, whence the seeds were brought by M. Hier, who, after trying to grow them at Montpellier, placed them in the Algerian experimental ground. In the first year the produce of fibre was 2,000 kilogrammes to the hectare (1,760lbs. to the acre): but as regards quality, the Chamber of Commerce, in Paris, held the article to be of but secondary value, as the filament is not of sufficient strength for even the slighter kind of cordage. The name of Corchorus textilis has been given, I believe, by M. Decaisne; but the catalogue goes on to say that competent judges have pronounced it identical with the *Jute* of India, the produce of *Corchorus capsularis*, (worth about forty francs the kilogramme,—about 16*s.* 8*d.* the lb.), and such is probably the case. As damp seems to affect its strength this fibre is only adapted to in-door use.

Mallow (mauve textile, Abutilon Indicum) thrives in Algeria, growing with wonderful rapidity and vigour. Its adaptation to the soil and climate is fully proved by the fact that the plants, which were sown in the experimental ground at the end of June had attained a height of 1 m. 50 (4 feet 10⅓ inches), at the close of September. The return was of 200 kil. fibre the hectare (176lb. to the acre). The Chamber of Commerce ranked it of only about equal value with the *Jute* above mentioned, while other judges were of opinion, that even with the defect of slender strength, and small power of resistance, the *Abutilon* may be expected to take the place of the *Phormium tenax*, which France has been wont to import from England.

Phormium tenax.—This plant, which affords the New Zealand Flax of the English settlers in that country, grows readily in Algeria, in spots where the soil is rather damp, as along the edges of the lines of irrigation. But the French manufacturers find the same drawbacks as the English in the use of this fibre for ropes. A remark is, however, made in the catalogue, to the effect that the species is not, perhaps, the same as that which yields the satiny flax of New Zealand.—Two kinds are recognized in New Zealand. For tying vines, and as a substitute for osier withes, it would probably be of some service.

Reed-mace (Typha latifolia, L.) has been considered a textile plant, but its fibre is too short for weaving, or for cordage. Still the plant should not be rejected; its stalks are applicable for thatching stacks, and sheds, and such rural purposes, and the fibres would probably be useful for paper-stuff.

Vegetable Wool.—Pliny states that the cypress-like trees which form forests at the foot of Mount Atlas, are covered with a thin cottony substance, which might easily be manufactured into cloth or stuff in the same way as silk. The fact has been admitted, but the general idea was that this substance was the produce of webs woven by the caterpillar of the Fir-tree. Recent experiments have proved that the needles of the Fir-tree do contain a cottony fibrous material, (which in Bavaria, in Holland, and in the Bahamas has been turned to some account), and a committee has been appointed to examine and decide the question.

2. Woods.

Under the head of native and introduced trees we have, in the Algerian collection, and in its descriptive catalogue, a series which, if not very varied or extensive, is accompanied with

Woods; abundant and of great value;

Sir W. Hooker on Vegetable Products. — Algeria. —

a remarkable amount of information, economical, commercial, and statistical, such as would be vainly sought in any other department in the Exhibition. For this reason I shall enlarge upon the subject, beyond what is practicable in any other collection, where similar authentic and dependable details are wanting.

The forests of Algeria, long overlooked, have now been the subject of investigation, both for the use of the civil and military service, and their extent and value are fully established. The principal masses of trees are found in the three provinces, according to the following Table, in which their leading features alone are indicated.

their distribution in the three provinces:

1. Province of Algiers.

I. *Province of Algiers*, 208,606 hectares (521,515 acres).

Canton of Algiers. *Cork Oak, Lentisk, Olive, Firs, Oak, and Evergreen Oaks.*
„ of Aumale. *Cork Oak, "Tablat," Fir, Aleppo Pine, Evergreen Oak.*
„ of Blidah. *Cork Oak, Fir, Cedar, Thuya, Olive, Aleppo Pine, Lentisk.*
„ of Coleah. *Elm, Ash, Olive, Fir, Cork Oak, Aleppo Pine, Lentisk.*
„ of Dellis. *Cork Oak, Fir, Lentisk.*
„ of Cherchell. *Elm, Ash, Fir, Cork Oak, Lentisk, Olive, Phillyrea, Evergreen Oak, Juniper, Thuya, Aleppo Pine.*
„ of Medeah. *Cork Oak, Olive, Lentisk, Aleppo Pine, Thuya, Evergreen Oak, Pistachio, Juniper.*
„ of Boghar. *Evergreen Oak, Cork Oak, Tamarisk, Olive, Lentisk, Aleppo Pine.*
„ of Milianah. *Evergreen and Cork Oak, Thuya, Lentisk, Pine, Pistachio, Juniper, Carob-tree.*
„ of Tenez. *Oak, Pine, Lentisk, Olive, Phillyrea, Pistachio, Thuya.*
„ of Orleansville. *Thuja, Lentisk, Phillyrea, Evergreen Oak.*

II. Province of Oran.

II. *Province of Oran*, 269,764 hectares (674,410 acres).

Evergreen Oak, Lentisk, Olive, Thuja, Juniper, Aleppo Pine, Kermes Oak, Phillyrea, Carob-tree, Tamarisk, Shumac, Fir, White Oak, Cork Oak, Juniper.

III. *Province of Constantine*, 630,657 hectares (1,576,642 acres). III. Province of Constantine.

Canton of Constantine. *Evergreen and Cork Oak, Pine, Ash, Elm, Brushwood, Aleppo Pine, Juniper.*

„ Batna. The same, with the addition of *Tamarisk* and *Cedar*, and no Cork Oak.

„ Setif. *Evergreen Oak, Lentisk*, and *Juniper.*

„ Beni-Salah. *Cork Oak, White Poplar, Elm, Ash, Willow, Tamarisk.*

„ Edough. *Cork Oak, Ash, Chestnut, Lentisk, Myrtle, Phillyrea, Olive, Arbutus, &c.*

„ Guelma. The same, but no Chestnut, Myrtle, Arbutus, or Willow.

„ La Calle. *Cork Oak, Elm, Willow, Ash, Poplar, Aspen, Alder, Tamarisk, Evergreen Oak.*

„ Philippeville. The same, with *Olive.*

„ Bouge. *Cork Oak, Elm, Ash, Olive*, and *Carob.*

„ Jemmapes. *Evergreen*, and *Cork Oak, Elm, Ash.*

Sum Total.

Province of Algiers	208,606 hectares	(521,515 acres)
„ Oran	269,764 „	(674,410 „)
„ Constantine	630,657 „	(1,576,642 „)
Total	1,109,027 „	2,772,567

The colony has imported hitherto, till its own forests shall be brought into use, wood, to the amount, in 1854, of 1,295,000 francs. But in 1855 the exportation of firewood to supply the army of the East began.

France imported, in 1853, including all descriptions of common wood, and the produce of wood (as Cork and Charcoal) to the value of nearly 70 millions of francs; and in foreign and ornamental wood to the value of nearly eight millions of francs.

Application of Timber.

Timber: its chief use, &c.

The greater part of the wooded districts is under the inspection of the Office of Woods, and is becoming the object of attention and experiment. The colonists obtain all they require for the purposes of building and burning; and there can exist no doubt either of the ship-building skill, or of the large supply of timber adapted to that use, when it is considered that Algeria furnished for three centuries a large

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Algeria.

piratical navy. A few forests have been ceded to private individuals, exclusive of those consisting of Cork Oak, which will be mentioned elsewhere. The allotted forests are as follows:—

In the Province of Algiers, the forest of Soumata, consisting of 90 hectares (225 acres), valuable for its Olive-Trees and Lentisks.

In the Province of Constantine, M. Barbaroux has acquired the right to take, during 20 years, 7,000 cubic mètres of wood (247,240 cubic feet) from the forest of Belizma.

At Cap de Fer, the Society of the Alelik is entitled to fuel for 40 years to supply its furnaces.

In 1855, a naval engineer was allowed to fell some wood in certain parts of Algiers and Constantine for shipbuilding.

Some temporary permits have been granted; among them that which promises the most valuable results is the grant of *Thuya wood*, in the Canton of Orleansville, to M. Lambert de Roissy, cabinet-maker in Paris.

Finally, each province is to have an Inspector, who will superintend the labours of re-planting, grafting, &c., as may be needful.

Products of the Forests.

Special uses of different kinds.

Almond Tree. Wild in the woods.

Arbutus, or Strawberry Tree. The wood is hard, and marked towards the root with pink and white veins, like an agate or onyx; it will be valuable for cabinet-work, if the colour and beautiful veining are preserved by varnish.

Hawthorn. A handsome, close-grained, and heavy wood.

Alder Wood, white and brittle, of a reddish-yellow uniform hue.

Heath (Erica arborea). A beautiful hard wood, peculiarly fit for making toys.

Carob Tree. The Arabs make utensils of its wood.

Cedar. Algeria, Mount Lebanon, and* the Himalaya are the three native places of this valuable tree. Two forests in the Province of Algiers consist almost entirely of it; and it is the principal tree in several forests in the Province of Constantine. Individuals attain a height of 18-20 mètres (60 feet), and a circumference of 5 or 6 (60 feet). The Cedar excels the Fir trees of Lorraine and Norway in dimensions, and equals them in strength. The fine grain, agreeable odour, and handsome colour of the wood are well known, add to which, that it is worked with great facility.

* Here, and probably quite correctly, the cedar of *Mount Lebanon*, the first and best known (Cedrus Libani), that of Himalaya, the *Deodar* (Cedrus Deodara), and that of Algeria, *Atlas*, (Cedrusargentea) are all considered mere forms of one and the same species.

Cherry. The young shoots are used for the stems of tobacco-pipes.

Chestnut. Very common, and often growing to a circumference of 4-6 mètres (12-18 feet).

Cork Oak. Abundant throughout Algeria, and valuable for its bark.

Evergreen Oak. Most of the Brushwood consists of this tree.

Zeen Oak (Quercus Mirbeckii). In vast quantities in the Province of Constantine: the wood is hard and heavy, and peculiarly fit for ship-building.

Oak with edible Acorns (Quercus Ballota). A hard-wooded Tree, growing on the ridges of Mount Atlas. The acorn is as sweet as a nut, and serves for food to man and beast.

Citron. Allied to the orange-tree. A hard wood, useful for small articles.

Cypress. An evergreen, resinous tree.

Cytisus. The wood is handsome, hard, and heavy: the heart is chestnut-coloured, and the newer layers are pale and whitish.

Maple. A heavy wood.

Ash. Two kinds grow in Algeria: wood useful for carts and wheels.

Fig-tree. The wood is white and soft.

Prickly Fig (Opuntia vulgaris?). Already mentioned under the head of Fibres.

Juniper. The wood is commonly called Pencil-Cedar, from the chief use to which it is applied: it may also be employed for the keys of Pianofortes.

Holly. A hard wood, and superior, both in fine grain and in dimensions, to the holly which grows in France.

Jujube, or Zizyphus Lotus. It grows everywhere, both wild and cultivated: the wood is hard. The fruit is supposed to have been the food of the Lotophagi.

Oleander. This lovely tree skirts all the streams in Algeria; its wood is close-grained, and hard, though beautifully and delicately shaded.

Laurel, or *Victor's Bay.* The wood is coarse-gained, pale, and brittle.

Lentisk (Pistacia Lentiscus). A wood likely to be valuable in ornamental cabinet-work, on account of its handsome deep brown colour and fine pores. It would combine and contrast advantageously with Olive and Thuya wood.

Ivy. It attains a great size in Algeria: the wood is white and soft.

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Celtis australis. The wood is hard.

Mulberry (the *White*). A tree which succeeds admirably in Algeria, and is very valuable for its leaves, which afford the most acceptable food to the Silk-worm. The common *Mulberry Tree* has long been naturalized in the colony.

Myrtle. A fine close-grained hard and solid wood, eminently adapted for Turnery, as it is easily cut and does not warp.

Alaternus. Hard and heavy, though coarse-grained wood; the heart is of a deep red brown colour, and the alburnum a delicate lemon yellow.

Wallnut. Too well known to need description.

Olive. One of the most characteristic Trees of Algeria, chiefly grown for its fruit and its oil, but also valuable as a wood, being beautifully clouded and veined; and attaining such dimensions as qualify it for chairs, sofas, &c. It is easily worked, though strong, and is equally useful to the joiner, cabinet-maker, inlayer, and turner.

Orange Tree. Wood and fruit alike prized.

Elm. Very common, and attaining a great size.

Date Palm. Cultivated for the fruit. The wood, which is worked with difficulty, by reason of its entangled fibres, is very hard and solid, and believed to be indestructible.

Poplar, the *white*. Wood white, soft, and coarse-grained.

Phillyrea. Very common: the wood is hard, heavy, and close-grained.

Firs (Pinus Halepensis, maritima and Pinea). The first grows in large forests, the second in groves, and the third, much rarer, is only seen in solitary groups.

Plane. The Oriental Plane is wild in Algeria, and attains a great size: the wood is hard.

Black Thorn (Prunus spinosa). A fine, hard, heavy, and close-grained wood.

Castor Oil Shrub (Ricinus communis). A light and soft wood. The seed is oily. (See Oils.)

Willow. A prettily grained, tender, brittle, and bright-tinted wood.

Service Tree. The wood is hard and useful: the fruit is eaten, and called Sorbs.

Shumac. The bark is useful for tanning and dyeing: the wood is not valuable.

Tamarisk. Resinous.

Terebinth (Pistacia Terebinthus). The wood is close-grained, hard, and resinous.

Thuja (the Citron wood of the ancients), its beauty, &c.

Thuja (Thuya articulata; Callitris quadrivalvis, *Vent.*). The most valuable wood known for cabinet-work, and which, though only recently appreciated in our times, was highly prized

by the ancients. According to Pliny, it was called *Citrus*, or *Citron wood*, and tables made of it were vended at fabulous prices, in some instances at a million of sestercia, or 350,000 francs (or 12,000*l.*!) The root was the most esteemed part: it was generally used for veneering, though cups of *Thuja* (or citron) were among the possessions of the Emperor Commodus. The exquisite beauty of the wood accounts (so to speak) for this mania. None is so rich in spots, veins, and satiny streaks; it takes a perfect polish; the hues are warm, soft, and bright, passing from fiery red to a delicate pink; while, unlike mahogany and rosewood, these colours are not darkened by exposure to air and light, but remain perfectly unchangeable. The Parisian cabinet-makers unanimously prefer the wood of the *Thuja* to all others.

It must be remembered that in Algeria other woods of similar appearance are sometimes also called *Thuja*.

Cork (its excellence in Algeria).

Cork, which is the well-known Bark of *Quercus Suber*, is one of the most abundant and valuable of Algerian productions. The *Cork Oak* figures largely in the enumeration already given of the forests in this colony, and the nature of the country is peculiarly favourable to the development of its precious bark, for Algeria unites an uniformly high temperature with profuse nightly dews, and the dry, warm, open hill-sides are covered with a sufficiency of light soil; under these circumstances Cork becomes finer in substance, more elastic, less porous, and freer from earthy particles than even in Spain, where the best European Cork is found. If the *Cork Oaks* in Algeria ever yield an inferior bark, it will be because many of the trees are stunted from the attacks of cattle, or damaged by the periodical conflagrations, injured, in fact, by the want of that regular attention which is indispensable for the produce of a good article.

Besides the manufacture of bottle-stoppers, which demand the best quality of cork, the bark serves for bee-hives, buoys, floats for nets, buckets, household articles, covering to trees which would suffer from exposure to the sun, and for soles of shoes, &c. In Kabyle it is used to tile the houses. The charcoal of cork is a valuable colouring substance, and known to painters under the name of Spanish Black.

On an average the *Cork Oaks* of Algeria are ready for the first barking when they are seven or eight years old; the process is performed about the middle of June, and the stripping is carried up to about two mètres ($6\frac{1}{2}$ feet) from the ground. In eight years the operation may generally be repeated, and the bark stripped off nearly one-fifth higher than at first, but it must not be removed for above a mètre ($3\frac{1}{4}$ feet) space below the main branching of the trunk; thus the quantity is

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doubled at the fourth or fifth stripping, and must never be carried further. There are strict regulations on the subject.

Each tree in full bearing is estimated to yield from six to eight francs' worth of *cork* at a stripping.

In 1853 the consumption *of cork* in France amounted to the sum of 150,000 francs in rough cork, in rasped cork 56,000 francs, and in manufactured cork nearly 500,000; making a total of rather upwards of 700,000 francs value.

3. Dye-Stuffs and Tannins.

Dye-Stuffs and Tannins; from wild plants.

The principal Dyes derived from plants which grow wild in Algeria are the following:—

Safflower, the produce of Carthamus tinctorius. It imparts a fine red colour to silk and wool, it is used for painting, and it also forms, when mixed with finely pulverized talc, a cosmetic which is used by the native women. From Algeria, and elsewhere, France imported safflower in 1853 to the value of 330,000 francs.

Madder (Rubia tinctorum) is a common weed in the North of Africa; but the quality of the African dye is proved by experiment to be inferior to that which is grown at Vaucluse, though the article has been exported from Tunis to a large amount for nearly 2,000 years. Possibly careful culture will yet be found to have great effect in improving the Algerian *Madder*. In 1853, France imported it to the value of nearly 750,000 francs.

Henna, made from the foliage of *Lawsonia inermis*, is extensively known as a cosmetic both for man and beast: the fingers and toes of the native females, and the tails and manes of horses, being tinged red with it. Chemical admixtures cause the *Henna* to impart a brown, orange, and almost black dye.

Attempts are being made at Algiers to cultivate Eupatorium tinctorum and Polygonum tinctorum, both formerly used for giving a blue dye, but now quite superseded in Europe by Indigo.

Gall-nuts, from the Evergreen Oak, are abundant, and serve to dye black. France had a consumption of this article in 1853 to the value of between 600,000 and 700,000 francs, and Algeria could well supply it all.

The dyeing *Lichens*, *Orchil*, &c., are abundant in Algeria. *Saffron* is cultivated. *Woad* is plentiful, wild. The *Shumacs* (Rhus pentaphyllum and R. coriarium) are used by the natives to dye the Leather commonly called Morocco, and it is therefore desirable to encourage their growth.

Tannins are afforded by the Bark of many Algerian trees, especially Oaks, but Fir, Willow, Chestnut, Elm, Alder, and Pomegranate are all more or less available for the purpose.

Other less valuable Dye-stuffs are used in Algeria: the pods of the Carob-tree give a yellow colour; so do the bark, root, and wood of the Barberry and Daphne. Ash dyes olive-green, the Wallnut a fawn-brown, the Elder yields varied hues of green, yellow, and brown; the berries of the Phytolacca and Mulberry afford red; while among herbaceous plants the yellow tints are chiefly imparted by Centaury, Chervil, Geranium, Lucerne, and Orchis; the green by Anemone, Iris, and Fenugreek; red by Carrot and Viperina (?); black by a Lycopodium, and a clear blue by an Euphorbia. In short, the secondary or less valuable Dye-stuffs are afforded by 15 arborescent and 21 herbaceous plants, 36 in all.

4. Esculent and Farinaceous Roots and Tubers.

Esculent roots, &c., not numerous.

Though the common *Potato* and *Batatas* are the principal roots which are eaten in Algeria, and though experiments are now making to acclimatize the *Colocasia*, *Caladium*, and *Yam*, yet the country produces some native eatable roots. These are the Phelipæa lutea and P. violacea, two remarkable root parasites; their bulbs, called *Denous*, are sliced, dried in the sun, and ground to a powder, which serves to eke out the flour of the different *Cerealia* in times of scarcity. Among the wretchedly poor inhabitants of the Sahara, it is collected and stored up, and with Dates, a little Maize, and ground Locusts, it furnishes their chief food. The *Tarsous*, supposed to be Cynomorium coccineum, is prepared and used in the same way; and so is the tuber of Bunium Bulbocastanum, which the French Soldiers, as well as the natives, consider highly palatable. Another article of food is derived from the almond-like knots, or suckers, which grow from the roots of *Cyperus esculentus*. They have an agreeable flavour, and are used in the preparation of a much esteemed orgeat; an oil is also extracted from them. The plant is raised from these knots or tubercles, which are dropped into shallow holes in the earth.

5. Fruits, Seeds, and Roots for Distillation.

Of these, Algeria produces many in a wild state. Alcohol and Liqueurs for the table are successfully extracted from the Arbutus, Carob-tree, Figs, Cactus or Prickly-pear, Aniseed Asphodel, and (of course) the Grape.

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Oil, &c.

6. Oil-Plants, Seeds.

In producing these Algeria is peculiarly rich. Some are grown solely for the production of oil, others are hitherto only the subjects of experiment. Fixed or fatty oils are as follows :—

First in abundance and importance comes the *Olive*. This tree grows naturally in Algeria, and acquires enormous dimensions. Most parts of the colony are adorned with it, whether in magnificent groves, small groups, or fine solitary stems rising from amid the dense brushwood. The climate, with its immunity from frost, is so eminently favourable to it, that neither the attacks of cattle, the axe of the Arab, nor the periodical fires, can destroy it. Algeria may fairly be called the Land of the Olive.

At the close of 1854, the number of Oil Mills conducted in the European manner were reckoned at 50, and the total produce of oil at 11,000,000 litres (44,745 hogsheads), 8,000,000 of which were consumed in the country, and the rest exported, mainly to France.

Among the other native and less important oil-bearing plants, may be mentioned the *Lentisk* (Pistacia Lentiscus), the oil of which is employed for greasing machinery and for burning; an oil is also extracted from a *Nettle* (Urtica ferox).

7. Volatile and Essential Oils.

The sunny and dry climate of Algeria is favourable for developing the perfume of different plants. Among these productions, indigenous to the soil, are Jasmine, Fennel, Mint, Parsley, Mignonette, Rose, Thyme, Violet, Rosemary, and an Iris which yields a favourite perfume, called by the Arabs Atar el Thar.

8. Peculiar Vegetable Juices.

Vegetable Honey is a name applied to several kinds of syrupy juices, more or less liquid, which are secreted by certain Algerian plants, especially the *Date Palm* and the *Common Cactus* or *Prickly Pear*.

The former yields a juice which flows from the severed branches; it is called *Lagmi* or *Palm Honey*. This fluid bears some resemblance to sherbet, and is much esteemed by the people, who draw it off night and morning for several days; but the tree will only bear this treatment for two years, and perishes if it be oftener repeated. The *Lagmi* turns by fermentation into a heady beverage, to which the Europeans add brandy.

The *Honey of the Prickly Pear* is of two kinds, one is a syrup, the other is as thick as honey; both are saccharine, and said to possess all the qualities of common Honey.

Vegetable Soap, again, is a name given by the Arabs (*Azeram* in their language) to the juice of the Ephedra fragilis, which the native women use in washing and bleaching their garments. The plant grows in the open sands and forms thick bushes. Cattle are fond of its stems.

9. Medicinal Plants.

Medicinal plants: native, and under trial of cultivation.

Algeria produces many Medicinal Plants, among which the *Pyrethrum* and *Sarsaparilla* constitute articles of regular traffic with Europe. The principal ones which are of repute, and are either native to the soil or are now being subjected to experiments for their improvement, are as follows:—

Acacia Nilotica, which yields Gum-Arabic.

Aristolochia rotunda, called *Boustum;* its root is a stomachic.

Armen is the native name of an hitherto undetermined plant, much esteemed by the Arabs, who use plasters of it to cure headaches, while in the veterinary practice its powder is applied to wounds and sores in horses.

Arum Arisarum (Bonkoka), a specific against stone and gravel.

Cyclamen Europeum. The root is a drastic purgative.

Dracæna Draco (Dragon's Blood). The resinous sap of the tree is an opiate and astringent.

Thapsia Garganica (Drias), very common in Algeria, is one of the chief remedies used by the natives, who deem it a specific against pains of all sorts, whether of the digestive organs, limbs, or head, and who consider every part of the plant, root, stalk, and leaf to be equally effectual. The plant is a deadly poison to camels.

Fennel is a fumigatory in Arabic practice, *Gentian* a febrifuge, and *Globularia fruticosa* a purgative. The *Tree Mallow* has the emollient qualities of its congeners; and *Henna*, though chiefly valued as a cosmetic (see above), is also used against numerous ailments, bruises, wounds, ulcers, swellings, toothache, &c. *Henbane*, taken internally, is a narcotic, its foliage applied outwardly is of a composing nature. *Lavander*, of which three species grow in Algeria, possesses in its flower-heads stimulating and restorative properties, and is much prized in veterinary practice. The powder of *Orobanche Mauritanica* is astringent, and used in diarrhœa; the leaves of the *Prickly Pear* (*Opuntia*), for a cooling application in cases of Gout. Rue, Squills, and Rhubarb are also esteemed, and *Earth-Nuts* are deemed

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carminative. Among the more remarkable exotic medicinal Plants of recent introduction, the *Mikania Guaco* holds a high reputation, as elsewhere, with truth or not, for the cure of snake-bites; and *Quinine* or *Peruvian Bark* is also prized.

10. Gums.

Gums and Resins: not many, *Lek* and *Mastic* the chief.

The chief of these are the *Mesteba* and the *Aourouar*. The former is indigenous to Northern Africa, and is vended in the markets of the Sahara; the *Aourouar* is also sold there, but it comes from the interior of Africa, and is all sent to England along with another and less white Gum, which is brought by the caravans from Timbuctoo, and which flows from a Tree called *Toleuhl*.

11. Resins.

The principal resins from the Algerian forests are *Pitch* and *Turpentine*, from the Fir; *Alk* or *Lek* (whence our word Lac), which is so profusely afforded by the Terebinth Tree, that it is dangerous to sleep under the Tree; the Lek is given to colts as a purgative; *Bêkrour*, which is obtained from a tree of the Sahara of the same name, and used for incense; *Sandarac*, which flows spontaneously from *Thuja articulata*, and is employed in making varnish and pounce; and *Mastic*, derived from *Pistacia Lentiscus*, and which derives its name from its common use as a masticatory; it has the reputation of whitening the teeth and sweetening the breath; it also enters into the composition of varnish.

A Bronze Medal was awarded by this Class to M. Hardy of the Pépinière Centrale du Gouvernement at Algiers, for his extensive contributions of Vegetable Products; and to M. Dubouchage for Cork; and to M. Royer for Woods; and to M. Simounet for various Vegetable Products; and to M. Testut for the same.

Jamaica.

III.—JAMAICA.

(Agent at Paris—M. Fremont.)

Jamaica collection: of great merit, due chiefly to its Government and Society of Arts.

Although this Island is but of small extent, being 150 miles by 55 broad, and containing only about four millions of acres, yet the collection of its vegetable Products must not be passed over in silence. Taken in conjunction with the carefully compiled catalogue of articles exhibited in Kingston, Jamaica, in February 1855, by the *Jamaica Society of Arts*, and forwarded to the Paris Universal Exhibition of the same year, and also with the Transactions of the Jamaica Society of Arts, commenced only in December 1854, and

forming a volume in 4to. closely printed, together with the continuous monthly numbers; bearing in mind, too, the unprosperous state of the country, there is no collection in the Paris Exhibition which is so highly creditable to the individuals who have formed it, and none which shows so fully and satisfactorily the position which this Section, at least, of the United Kingdom holds, as compared with foreign countries, in the Paris Universal Exhibition of 1855, nor one which demonstrates so plainly the progress which has been made by us since 1851, as the one now under review.

The Jamaica Society of Arts had its origin under the Government of Sir Charles Grey. Owing to various untoward circumstances, it was soon almost extinct; but, "as the Great Exhibition in London of 1851, under "the patronage of Prince Albert, became the means of "awakening and diffusing new life into some almost defunct "Art-Societies of Britain, which had been in existence for "nearly a century, so has the Paris Exhibition roused into "activity the Society of Arts of Jamaica." Sir Henry Barkly, the Governor, convoked a meeting of the Society in Spanish Town on the 30th August 1854, and he communicated the wishes of the Duke of Newcastle regarding the transmission to the French Capital of such articles as should illustrate the industrial and other resources of the colony. The very first number of the Society's Transactions evinced the zeal with which the undertaking was commenced. "If," say they, "for the Great Exhibition in 1851, a box of *Arrow-root* from "Montserrat, a solitary *Fish-pot* made by a black labourer in "St. Kitts, a specimen of *Seaside Grapes* from Barbados, a "box of *Indian Meal* or *Maize* from British Guiana, a few "*Physic-Nuts* from Demerara, *Cashew* and *Prickly Pear* from "the Bahamas, *Starch* and *Cocoa-nut Oil* from Trinidad, *Ornamental Woods*, numbering 225 specimens, from Cuba, and a "small piece of *Fossil-wood* from Antigua; if these were gladly "admitted to the Great Exhibition, and much curiosity excited "concerning them, why should not Jamaica, which abounds in "every one of these articles, and thousands more, equally "valuable and equally objects of curiosity and interest, why "should not Jamaica do justice to herself and take the high "place assigned her by Providence in the productive industry "of the world? We grieve to remember, that while departments were allotted in the Exhibitionof 1851 to each one of "the British Islands, some of these Islands did not avail themselves of the proffered privilege. Hence the anomalous "announcement which presented itself in the vacant space, "'*St. Domingo, no return*,' '*Granada, no return*,' while "Jamaica was not named in the Index as an Exponant at all.

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Jamaica.

"Let us not perpetuate our disgrace, but endeavour by a "combined movement to render justice to the land wherein "our lot is cast. Were we to send no more than some speci- "mens of the beautiful Furniture manufactured in the "island, and so to prove the advance we have made in civili- "zation and the comforts and decorations of our dwellings, "this would be something, and would serve to show that "we do not live like savages in mere huts and log-houses. "Jamaica owes a debt of gratitude to Sir Henry Barkly, and "those gentlemen of the Society of Arts, who at much "expense of time and labour are endeavouring to retrieve "the Island from the blame it has already incurred. It were "difficult to assign any good reason why the gifts of the "God of Nature, which are here bestowed in such immense "variety of texture and of fibre, should not become articles "of commerce, and be yet fabricated into forms of surpassing "elegance and exquisite workmanship."

Transactions of the Jamaica Society of Arts.

It should be recollected, that it was during the continuance of the Paris Universal Exhibition, as well as for some little time previously, that the Meetings of the Jamaica Society of Arts were held. It is therefore only just to the Members that I should briefly mention those articles in the Transactions which bear upon this special Department, before considering the Contents of the Jamaica Collection at Paris, and especially the original articles, which are numerous, and many of them very instructive and valuable. The very first paragraph recommends attention to the *Cassia Senna* of Jamaica. This plant grows, apparently indigenous, on the burning beach by Fort Augusta, and on the arid sands of the Port-Royal Pallisadoes, spots which are eminently favourable for the development of its peculiar principle, known as *Cathartine*. It might be advantageously collected for the Druggists. 2. On the application of *Cane Trash* to the manufacture of Paper, with advice as to the mode of preparing it. 3. Notes on *Manilla Hemp*. 4. Here, too, is published a copy of the excellent letter of G. F. Wilson, Esq.* (alias Price and Co.) to Sir Wm. Hooker, on the simplest mode of ascertaining the commercial value of Vegetable oils, Oil-nuts, &c. 5. On *Nettle Oils*, and on *Tannins*, especially on Mangrove roots, by Charles Grant, Esq. 6. On Texas *Millet*. 7. On *Fibres*, by Mr. Wilson (to be more fully noticed by-and-by). 8. On a superior *Artists' Oil*, procured from *Aleurites triloba*. 9. On a *new Hard-wood*, introduced from the South Sea Islands, Casuarina (muricata?) Extremely hard as is the would the growth of this tree is so rapid, that an individual

* Already quoted at note p. 18.

planted in the Garden of the late Dr. MacNab attained a height of about 50 feet in seven years. This, and many other contributions, are from the pen of the Hon. E. Chitty. 10. On the *Oil of Ben* or *Ben*, afforded by the seeds of Moringa pterygosperma, showing how profitably it may be cultivated. 11. On *Plantain-fibre*; many important observations, and a description of the machine for breaking and cleaning the fibre, by the Hon. F. Burke, of Montserrat. 12. On *Starches*. 13. On *Citric Acid*. 14. On the textile properties of the fibre of the *Trumpet-tree*. 15. *Starch*, from the *Sour-sop*, *Anona muricata*. 16. The whole of No. 4 is devoted to the Catalogue of the Collection in the Paris Universal Exhibition. At p. 51, a permanent Museum, illustrative of the useful products of the Island, is recommended, and eventually sanctioned. "Putting aside," say they, "all other considerations, "such an Institution is, for Trade and economic purposes, an "indispensable requisite. The business of Traffic, and the in- "genious labour of the Artizan, are alike effectually served by "exhibiting in detail the materials of which the Trader and "Manufacturer both stand in need." Several pages are devoted to instructions for forming collections, from the best authorities; and that relative to collecting Woods is well drawn up, apparently with the assistance of Dr. Lindley. 17. A *List of native Medicinal Plants* (including, however, many imported ones) is very extensive; it gives the popular, vernacular, and the Latin names, arranged systematically, and a word or two indicating the part of the plant, whether Root, Stem, or Seed, &c., which is employed. The number exceeds 400. The properties of many, doubtless, require to be further tested; and in several cases the plants should be expunged. 18. The Statistical Table of Imports shows that a great number of similar and equally valuable articles may be had in the Island. For instance, "our Staves, Headings, Shooks, "Shingles, &c. &c., obtained from native woods, require only "to be better known to compete with those which we import." 19. No fewer than 23 plants, yielding valuable Dye-stuffs, natives of Jamaica, are enumerated; and the writer goes on to say, "With these and other such resources, what might not be "effected in this branch of industry alone? Thousands are "living in the neighbourhood of these dye-woods who know "nothing of their value. Be it ours to bring them into notice, "and, by the diffusion of such useful knowledge, to introduce "a new era into an Island where wealth is so profusely scattered "around, and the inhabitants of which might, if industrious, "rank among the happiest people in the world." 20. On *Tamarinds* and the advantageous use of them. 21. On *Panama Hats*, a manufacture of great beauty, and very

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profitable, from the *Carludovica palmata.* The plant had just been introduced to the St. Thomas' Botanic Garden from Kew, and might be cultivated to any extent. 22. Bread from Yam flour. 23. On the *Cashew Nut,* the fruit of Anacardium occidentale. 24. Essays on *Plantain Meal, Plantain Starch,* and the Starch and Meal of the *Sweet and Bitter Cassava.* 25. *Amadou,* from the male Catkins of the *Bread-fruit* (Artocarpus incisa). 26. On Biscuits made from the Coco, Yam, and Bread-fruit. 27. On *Black Pepper* (Piper nigrum), and a native Pepper (P. Amalago). 28. On the exchange or interchange of Exotic Plants. "We owe "the Mango-tree to a French East India-man, bound to His- "paniola, and which was captured by Lord Rodney's Squad- "ron and brought to Jamaica, in 1782; this tree is now one "of the commonest in the Island. The beautiful *Akee-tree* "(Blighia sapida) was brought in a Slave Ship from Africa, and "the *Barbados Pride* (Melia Azedarach) from the South Seas, "and the *Camphor Tree* (Laurus Camphora) from China. The "*Date Palm* was introduced into Jamaica, soon after the con- "quest of the Island by the Spaniards, to whom we also are "indebted for *Ginger-plants,* and for the *Orange* (sweet and "bitter), the *Lime, Lemon, Citron,* and *Shaddock.* The *white* "*and black Mulberry* came to us from Persia. The *common* "*Fig* of Europe has long been naturalized here. The *Maize,* "the *Prickly Pear,* the *Guinea Grass,* the *Palmetto,* and many "others which now rank among our commonest and most "valuable plants, are also exotics, and of comparatively recent "acquisition." On the other hand, Jamaica has contributed many useful Trees and Fruits to other Tropical Regions, especially to Western Africa. 29. On the *Divi-Divi* (Cæsalpinia coriaria), a native of Carthagena, now cultivated in the East Indies for its tanning properties; the pods yield 50 per cent of Tannin, and 2,800 tons (valued at 40,000*l.*) were imported into Britain in 1854, principally from Curaçoa, New Grenada, and Venezuela. 30. On the commercial *Quassia, or Bitterwood.* This is an excellent essay (signed Q. L. B.); it shows that three plants have been confounded under these names. 31. At p. 126, is a memoir on the "Causes of the "Evils which tend to the prostration of Jamaica" which well deserves the attention of all who are interested in the Island. 32. On *Cassareep,* the inspissated juice of the Bitter Cassava. 33. On the *Aloes* of Commerce, with the proper means of collecting the juice. 34. On *Holcus saccharatus,* a grass lately come into notice, and absurdly vaunted as a substitute for the sugar-cane. The writer shows these statements to be exaggerated and futile. 35. On the *Jamaica Dogwood* (Piscidia Erythrina). 36. On *Hoops* and *Ox-bows,* advantageously

made of the wood of the *Rose Apple* (Eugenia Jambos), which is an excellent article for cooperage. 37. On the fibre of the *Jerusalem Dagger-plant* (Yucca aloifolia). 38. On the *Assam Silk-Insect* (Bombyx Cynthia). It was introduced from Assam first to Malta, where success had been anticipated, as the climate suits the *Castor-oil Plant* (Ricinus Palma Christi), on which the worm feeds. But the expectation was disappointed, the *Bombyx* will not thrive there. It however promises to do well in Grenada, and will, in all likelihood, succeed in Jamaica, where it has been recently tried. If it can be made to answer in Jamaica, a great point will be gained, as deriving a double advantage from the Castor-oil plant, which already proves a valuable article of cultivation in the Island. The subject of this substitute for silk has attracted much attention in France.

Want of space compels me to omit the briefer though perhaps scarcely less important notices, and to hasten to the Jamaica Collection, as displayed in the Paris Universal Exhibition, 1855, and to the Catalogue already noticed. Of the latter I must observe, that it shows much practical and scientific acquaintance with the different objects, which are named both botanically and vernacularly, and with an accuracy second to none prepared on this occasion. The first six pages (4to) are devoted to a brief general Natural History of Jamaica, its geological formation, climate, products, &c.

I shall follow the arrangement of the vegetable (chiefly native) Products, as they stand in the Catalogue.

Forest Products, including Woods of all kinds, Fibres, and Manufactured Fibres, Barks, &c.

1. Woods.*

Forest products of Jamaica. Woods: a large, valuable, and generally well-named collection.

This Collection attracted the attention of all Visitors, from the great variety and size of the specimens, and their careful nomenclature. A few, indeed, lacked the botanical names, and, doubtless, some other woods might have been added; still the Collection hardly required the apology that is given in the Catalogue.—"There are many valuable woods yet to be "found in Jamaica, but the time (only a few months) allowed "for collecting them, and especially for procuring seasoned "samples, forbade it. Errors must be pardoned, as the means "of determining species accurately by obtaining flowers and "specimens, was not afforded." It will be gratifying to know that arrangements have been made to purchase this collection

* Chiefly exhibited by the Honourables Edwd. Chitty, Mr. Ellis, the Rev. Thos. Wharton, and M. J. Wilkinson, and by Messrs. W. Berry, Prestwidge, L. R. Valpy, and Lee.

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en masse by the British Government, and that it will be deposited entire in the Museum of the Royal Gardens, Kew. Small samples were allowed to be subtracted by the English Government from the specimens, for the purposes of experiment and analysis. I am not aware that the results are yet made public.*

Napoleon Coffee-trees. The wood of these trees is well adapted for Hat-racks; but the chief interest of these specimens lies in the fact that the Emperor Napoleon the First drank coffee made from the berries of these very trees, which were consequently offered at the close of the Exhibition to the gracious acceptance of the present Emperor of the French.

The *Jamaica Mignonnette,* Lawsonia inermis. A block of this wood is exhibited, which is hard and takes a good polish.

Fustic (Morus tinctoria). An useful yellow dyewood, much superseded now by the brighter Quercitron Bark of America. The wood is admirably adapted for the felloes of carriage and cart wheels.

Lignum Vitæ (Guaiacum officinale). A very hard wood, used for the rollers of pulleys, for pestles and mortars, &c. The resin is the medicinal Guaiacum, and a decoction of the bark is esteemed by the natives as a specific for the cure of rheumatism. The tree is very common in the south of the Island.

Casuarina (*muricata?*). A hard, heavy, yet quick growing wood. A block, which almost defied the axe, was exhibited; the tree from which it was taken had attained a height of 40 feet in four years. Walking-sticks are made of another species of *Casuarina*, and it is probable that it would afford a good material for wood-engraving.

Bitter-wood (Quassia excelsa). A wholesome bitter tonic is obtained by steeping the chips in water. The timber is valuable, and insects will not touch any furniture that is made of it. Several cups of *Bitterwood* were exhibited; in using them, nothing more is needed to produce a *bitter morning draught* than to fill them to the brim with water overnight, and to keep them covered till early morning. The virtue resides for a long time in the wood.

Water-wythe (Vitis Indica). A wild Vine, yielding large bunches of small black grapes; the stem attains a diameter

* The Jamaica collection of Woods here noticed has, since the above was written, furnished Captain Fowke with samples of thirty-eight different kinds for his important series of experiments on the strength and resistance of various woods, as detailed in "Part I. of the Reports of the Paris Exhibition, presented to both Houses of Parliament by command of Her Majesty." London, 1856, p. 467, &c.

of six inches in the forest, and often affords a most grateful and wholesome beverage to the thirsty traveller. Two incisions made by a cutlass through the main stem, the first high up, and the second about four feet lower down, cause a cool sap to issue abundantly from the lower gash. The fruit would well repay cultivation.

French Oak (Tecoma longissima). A large tree; planks and boxes of it were exhibited.

Prickly Pole (Cocos Guineensis, or Bactris minor). The outer wood is intensely hard and very elastic, good for ramrods and arrow-tips, and beautiful for veneering.

Fiddlewood (Citharexylon melanocardium). A most serviceable Timber tree, and said to yield a fine yellow or orange colour.

Black-heart Ebony, or *West Indian Ebony* (Brya Ebenus). Hard and ponderous, and susceptible of a very high polish; it is very common in the Savannahs and dry hills.

Bastard Bullet-tree, or *Galimeta wood* (Bumelia salicifolia). A good timber-tree, if not exposed to weather.

Curled Mahogany (Swietenia Mahogani, var.) For Furniture, water-wheels, &c.

Black Dogwood (Piscidia Carthaginensis). A most useful tree, equally durable in or out of water; its bark has narcotic properties, and has been used to calm maniacal excitement, and to stupify fish.

Broad-Leaf (Terminalia latifolia), also called Almond Tree from the taste and shape of its nut. The outer coat of the nut is fleshy, soft, and insipid; bats are fond of it. The shell is very thick, and the nut, consequently, extremely small; its flavour is pleasant. The tree grows 60 feet high before branching, and has a circumference of 12 to 18 feet.

Spanish Elm (Cordia Gerascanthus). Good for carts, staves, &c., and when young, for hoops.

Yellow Prickle (Xanthoxylon Clava-Herculis). For furniture, inlaying, &c., and said to afford a dye, and to have medicinal properties. A very common Tree.

Sweet-wood (Laurus Borbonia). For boards, &c. A large and abundant Tree.

Orange (Citrus aurantium). Valued for inlaying and for walking-sticks. The orange tree is very common, but thrives best in the brick-clay districts.

Blue Mahoe (Hibiscus). For the bodies of carriages and waggons; much used for furniture. This and three other species, *H. elatus, tiliaceus*, and *clypeatus*, are highly prized for the strong fibre they yield for cordage.

Ironwood (Erythroxylon arcolatum). Furniture and flooring.

Cogwood (Laurus chloroxylon). The best material for mill-wheels, being uninjured by water.

Mahogany (*green*). Swietenia Mahogani.

Calabash Tree (Crescentia Cujete). This species, and C. cucurbitina, both abound in Jamaica, and are serviceable in many ways, their wood being light, tough, and pliant, and the fruit well adapted for vessels and other domestic purposes.

Pigeon-wood (Guettarda ——?) Two very different trees bear this name; both afford valuable timber.

Lance-wood (Guatteria virgata). Prized in Jamaica, as in England, for shafts of carriages, bows, whips, and various purposes which demand strength combined with elasticity.

Prune (Prunus occidentalis). The wood is used for mill-framing, &c.; the plant yields an excellent liqueur.

Tamarind (Tamarindus occidentalis and Indica?) A large tree, of good timber.

Locust (Hymenæa Courbaril). The timber is used for boards and house-framing; it is hard and tough. From this tree the valuable substance, called Gum Animi in the West Indies, exudes; it affords a varnish said to excel the Chinese Lac.

Savannah Candlewood (Cassia?) So called from its burning like a torch. The wood resembles Satin-wood.

Genip (Melicocca bijuga). A large tree, originally imported from Surinam.

Bastard Tamarind (Acacia trichophylloides *Mc.Fad.*—A. angustiloba, *D.C.*) A tree, from 10 to 40 feet high.

Braziletto (Cæsalpinia Brasiliensis). Wood used for ornamental cabinet-work or carriage-spokes. C. echinata has superseded it as a dye. The tree seldom exceeds fifteen feet high.

Cocoa-nut Palm (Cocos nucifera). It is difficult adequately to estimate the various uses of this tree. As a wood, the outer part of the trunk yields the beautiful *Porcupine Wood;* and horizontal sections, taken within a foot or two of the root, make exquisitely handsome round tables. Its spatha and flowerstalk would afford good splints and slings for the use of surgeons.

Wild Tamarind (Acacia arborea) and *Bullet-tree* (Bumelia montana,) are also ornamental woods. *Cashaw* (Prosopis juliflora); the timber is generally useful for ship-building, and is said to be under examination at the Admiralty for this purpose. The chief drawback lies in the difficulty of inserting nails, for which holes must be bored in the very hard wood. The trunk yields an abundant gum, very like Gum Arabic, also a serviceable fibre; its charcoal promises to be valuable.

Naseberry Bullet-tree (Achras Sideroxylon). Very lofty, and one of the best Timber-trees in Jamaica.

Maiden Plum (Comocladia ?), also called Burn-wood and Papaw-wood; the tree seldom attains more than 16 feet in height; the wood is hard, and used for cabinetwork.

Palmetto Thatch (Chamærops), used for thatching.

Cinnamon (Canella alba). This is a common tree; it is called Wild Cinnamon, and its bark is commonly used as a substitute for the true Laurus Cinnamomum.

Bastard Cabbage-tree (Andira inermis). The tree is of moderate height, its wood is very tough and useful. The bark possesses emetic, drastic, and narcotic qualities, and is employed as a vermifuge.

Palmetto Palm (Thrinax ?) A tree, which covers a large extent of ground in many places, but seldom grows to more than four or five inches thick; it is much used for making fences, and is often called "Thatch Pole." Its unexpanded leaves and flower afford a good vegetable and a pickle like Mountain Cabbage. The footstalks of the leaves are very tough, and when pared and split, may be woven into baskets, ropes, and bowstrings, and serve many uses where strength and toughness are required. The leaves are commonly called Thatch, and are well adapted to that purpose, as they are uninjured by the exposure, even of many years, to the weather.

Cedar (Cedrela odorata). The straight and lofty stem, often attaining a height of 80 feet, affords excellent planks. and when hollowed out, makes good canoes, as it is very light Insects avoid it because of the smell; and it yields a clear and abundant gum.

South American Acacia (Inga Saman). The wood is said to be peculiarly well adapted for gun-carriages.

Maccaw Palm (Elais Guineensis). The oil and fat which this Palm affords is called Maccaw by the negroes, who use it for culinary and other purposes.

Yacca (Podocarpus Yacca). A common tree, used for ornamental cabinet-work.

Sea-side Grape (Coccoloba uvifera). The source of Jamaica Kino; the wood might be useful for blocks for engraving.

Mountain Cabbage (Areca oleracea). Its spatha would serve for splints and slings for surgical purposes. When fully expanded, the spatha makes a beautiful mat, often used for wrapping infants. The fruit, when young, is a good pickle; and the upper part of the tree, just below the leaves, yields, when boiled, a delicious vegetable called the cabbage; it is, however, procured like that of other palms, at the expense of life to the tree.

Wild Cane (Arundo Tabacaria), is useful for arrows, easel-sticks, &c.

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Agave Americana. The withered flowerstalks, which may be gathered in immense quantities, would be applicable to many purposes; the plant yields, in its fleshy juicy foliage, an excellent substitute for coarse soap.

Besides the above-described Woods, there were exhibited Walking-sticks, made of nearly 20 kinds of trees, the principal including the Orange and Lemon and Shaddock trees, Coffee, Pimento and Lace-Bark, Iron-wood, Prickly Pole, and Bitter Quassia.

2. Fibres.*

Fibres of Jamaica: numerous and correctly named.

No exhibitors have shown, I believe, an equal amount of different fibrous plants, so correctly named, as those of Jamaica. In most collections, Plantain, Wild Pine, Aloe, Pine-apple, and other appellations, have been given quite at random, and it was impossible to tell the particular plant which the exhibitor might have in view; but here each kind is accompanied with its scientific name, removing all doubt as to identity. Experimenters on fibres are too apt to forget that, without accurate nomenclature, their labours can produce no efficient results.

Silk Grass (Bromelia Karatas), *Pine Apple* (Ananassa sativa), six kinds of Musa, called *Banana and Plantain*, the *Screw-tree* (Helicteres Jamaicensis), *Bastard Cedar* (Guazuma ulmifolia), an *Ochroma*, the *Trumpet-tree* (Cecropia peltata), four species of *Cordia* (one of which is called by the well-known name of *Man Jack*), the *India-rubber tree* and *Peepul* (two kinds of Ficus) *Heliconia psittacorum*, *H. Bihai*, and *H. Braziliensis*, a *Sida*, a *Kleinhofia*, two kinds of *Tillandsia*, which grow on trees, (one of them is *T. usneoides*, used by upholsterers as a substitute for horse-hair); the *Screw-Pine* (Pandanus spiralis), *Indian Shot* (Canna Indica), *Burbark* (Triumfetta semitriloba), *Bastard Mahoe* (Hibiscus arboreus), two kinds of *Ficus*, six of *Hibiscus* (H. tiliaceus is said to be the best), an *Abroma* and a *Kydia*, the *Lace-Bark* (Lagetta lintearia), *Burn-nose Bark* (Daphne tinifolia), *Cocoa-nut Palm*, the *Jack-fruit and Bread-fruit* trees (two species of Artocarpus) the *Rattle-Wort* (Crotalaria juncea), *Pterocarpus santalinus*, two species of *Adam's Needle* (Yucca aloifolia and gloriosa), and the *Common Pinguin*;—50 in all, of which the Adam's Needle (Yucca gloriosa) is the best and the strongest fibre which Jamaica produces.

We heartily concur with the compilers of the above list, that it is a "matter of regret that the specimens of Fibres

* Exhibited by the Honourable W. J. Wilkinson, L. R. Valpy, Esq., Mr. Wilson, Curator of the Botanic Garden at Bath in the Parish of St. Thomas in the East, and by the Honourable E. Chitty.

Specimens valuable, but in too small quantity.

"were not accompanied by larger ones in the rough," following the example of Dr. Royle and of the Algerine collection. Admirably as these Jamaica fibres are prepared, "they do not afford a sufficient opportunity of testing their "several qualities."

Mr. Wilson, who prepared the fibres, remarks, "the above "list comprises fibres of all qualities and colours, from the "coarse cocoa-nut Coir to filaments like fine silk, not to be "surpassed in strength and lustre. More might have been "added; but I have enumerated enough to convince the "most sceptical, that Jamaica abounds in highly valuable "textile plants, some of which are considered only trouble-"some weeds. The ligneous ones annually produce two "crops of shoots, from which may be obtained a good fibre, "which requires no machinery in preparing it for market. "The easy method I have pursued is that of macerating the "shoots, till the outer cuticle loosens freely from the inner "bark." The latter then separates readily from the woody part, and the fibre is soon cleared, dried, and packed. Children, aged and infirm people, who could not work in the Plantations, can do this. For the *Plantain*, *Pinguin*, and such herbaceous plants, machinery is, however, absolutely necessary to detach and cleanse the fibre properly. When this difficulty is overcome, which a year of practice will accomplish, there is nothing to prevent the fibres of Jamaica from competing with those of countries ten times as large as that island.

In the transactions of the *Jamaica Society of Arts*, Mr. Wilson mentions another fibre, that of *Pothos violacea*, "which is admirably calculated to replace every description "of fine straw-plat, even the best Leghorn from Italy, which "it rivals in strength and lustre. Though the plant be "naturaly an Epiphyte, growing plentifully at the roots and "even the tops of lofty trees, at an elevation not below "1,000 feet above the sea, it may be readily cultivated in "wooded and moist places. It is the footstalk of the leaf "which yields the fibre; it is about eighteen inches long, "and easily separable into stripes of various dimensions; its "colour too is durable." I cite this account the more particularly, as I do not find the plant mentioned in the Catalogue; though Mr. Fremont, the attentive Agent for the Jamaica Collection, in writing from the Universal Exhibition to the Committee in Jamaica, makes the following statement: — "Among the fibres exhibited are two "samples, flat and straight, looking like* Palms, but ticketed

* It would seem that Mr. Fremont gives the above particulars because our Jury, at the time of inspection, directed his attention to the sample of fibres in question, and pronounced them to be incorrectly named *Pothos violacea*. This

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"*Pothos violacea:* one sample is whiter than the other, and "has particularly attracted the attention of a straw-hat "manufacturer for making hats, of the kind and quality of "those which you have sent to the Exhibition. The "manufacturer is desirous of attempting to work up the "article; he will gladly, and with as little delay as possible, "take the quantity specified in the accompanying order; "and if it answers satisfactorily, it will be an opening to "business with a merchant of the Colony, who may be "commissioned to execute the order."

*Ornamental articles made of Fibres.**

Articles, made from fibre in Jamaica, numerous and pretty.

Many of these are, indeed, more curious than useful; yet they should not for that reason be despised, seeing that they give employment to the poor and the industrious. Not a few of them too, are made of beautiful substances, worthy of being brought into notice, and capable of being turned to better account. Among them are Bags, Baskets, Strainers, Sieves, Hats and Caps, made from the fibre of the *Strainer-Vine* (Momordica Luffa), a perfectly new material for such purposes, new at least to Europeans. Pretty as the articles undoubtedly are, it is only right to say that a greater variety, and of more useful kinds, will be noticed in this Report, as sent by other countries. The substance itself is well known. From various Tropical countries there have frequently been brought to England, as curiosities, certain very light dry Gourds, of the shape and about the size of a Cucumber. When the outer coat is broken up, the whole interior is seen to be filled with a highly beautiful, spongy, compact net-work of fibres. This fibrous mass is not unfrequently used for washing and wiping dishes; and with our sailors, it commonly goes by the name of *Sponge Gourd*, or *Towel Gourd*. It is the *Momordica Luffa*, called by some writers Luffa Ægyptiaca, Egypt being considered its native place, though it is now extensively cultivated throughout the Tropics. Some of the articles made of this curious substance, which I shall hereafter have occasion to notice, are exceedingly beautiful.

Bonnets, collars, head-dresses, slippers, whips, halters, baskets, and reticules of *Lace Bark* (Lagetta lintearia), are

assertion is confirmed by the statement above, that the "petioles or leaf-stalks are 18 inches long, and capable of being platted into hats." The petioles of *Pothos violacea* scarcely exceed an inch in length, and it is quite impossible, from their nature, that they should be "easily separated into strips of various dimensions." This error, however it may have originated, will, no doubt, soon be rectified.

* Contributed by the Honourables R. Hill and E. Chitty, Mrs. Nash, Miss Crew and Miss Levy, and L. R. Valpy, Esq.

among the articles in this collection. The exquisite substance in question, constitutes the inner layers of the Bark of the Daphne Lagetto (or Lagetta lintearia); it is of most delicate texture, and without any artificial preparation, resembles fine lace. The small branches, or the innermost layers of the larger and main-stem, afford the finest quality. The tree is 20–30 feet high, quite peculiar to Jamaica, and only found in certain districts there.

Similar articles are contributed made of various fibrous substances, as *Cocoa-nut* and *Papaw Barks*, *Pinguin* and *Plantain fibre*, *Palmetto* and *India-rubber Fibre*, &c.; variously combined with one another, and often ornamented with different seeds, &c., as *Job's tears*, *Mimosa seeds*, *Soap berries*, and *Crab's eyes* (Abrus precatorius). In one instance, a small box, composed of *Lace bark*, *India-rubber plant*, *Pinguin fibre* and *Plantain fibre*, is lined with the spathas of the young shoots of the *Bamboo*, a substance which is now wasted in enormous quantities, yet seems capable of being converted into excellent paper. A very fine plaited fan is made from the *common Palmetto*, and *Brushes* and *Hats* of *Guinea Grass* (Panicum jumentorum), which yields a most valuable fodder for horses, its culms sometimes measuring eleven feet from root to tip. The down of Clematis dioica, trimmed with moss, affords the quaint material for a lady's fancy collar, not made, however, we presume, to be worn.

Ropes, *Mats*, *Fishing-lines*, *Halters*, and *Crochet-work* are made of *Banana* fibre, of the root of the *Mangrove tree*, the bark of the *Mahoe* (Hibiscus), *Trumpet-tree* (Cecropia), *Adam's Needle* (Yucca), and *Mimosa*; bonnets and card-racks, &c., from the sheath of the *Maize or Indian corn*.

The hats made of *Fan Palm*, are in imitation of the famous Panama hats.

3. Roots.

Roots (chiefly cultivate

These are mostly cultivated; I must except, however, those of the *Mangrove* (Rhizophora Mangle), which are valuable for tanning nets and fishing-lines; those of the *Celandine or Parrot weed* (Bocconia frutescens), useful in affections of the eyes both of man and beast; also the valuable *Cassava* (Jatropha Manihot), which affords various articles of food (*Tapioca*, *Cassareep*, *Starch*, *Cakes*, and *Bread* being made of it); *Smilax Sarsaparilla* (the Jamaica kind, considered, I believe, to be native), the *Negro Yam* (Dioscorea sativa), the tubers of which, when sliced and dried in the sun, furnish an excellent and nutritious meal, convertible into bread, cakes, or puddings, and which has the advantage

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of keeping for years; the *Affo Yam* (D. aculeata), and the *White Yam* (D. alata), all good for food, and the *White Coco* or *Eddoe* (a variety of Colocasia esculenta).

4. Miscellaneous Products.

Miscellaneous products, as sugar, coffee,—not properly falling into this Report; a few only being from wild plants.

This head includes general vegetable productions, for example, Sugar and Cane, Coffee, Rum, Pimento, &c., Starch, Peas and Beans, Flour, &c., Medicinal ingredients, &c., Oils, Gums, &c. Consequently, the majority of the articles being cultivated and manufactured, they do not come under the inspection of my class. They are numerous and interesting.

I proceed briefly to notice a few, viz. *Eugenia Pimenta* (or Allspice), and its foliage, the latter being used, dried, for tea. *Bilimbi* is the fruit of Averrhoa Bilimbi; it yields an intense acid. *Cashaw-seeds* and *seed-pods* (Prosopis juliflora), in various states, for experiment; they afford a highly nutritive food for horses, but if eaten off the ground in wet weather, the effect of the rapidly germinating seed is to swell so rapidly and enormously as to burst the poor animal's body and cause death in a few hours; the only hope of relief is by prompt treatment with Alkalies; the seeds should be carefully picked and kiln-dried, they would then cause a great saving of corn. *Antidote Cacoon* (Feuillea scandens) is a popular remedy in many complaints; the nuts are so full of oil, or fat, that when skewered on a piece of stick, they blaze like a lighted torch. *Annotto* (Bixa Orellana) is chiefly used in Jamaica to colour soups and curries; it affords the so-called Aurora dye, (and is employed in Europe for staining butter and cheese.) *Sand-box* is the name given to the seed-vessels of Hura crepitans, which are occasionally applied to that purpose, as they have natural perforations at the top; but it is necessary to bind them with strong twine, or they burst in dry weather with great force and noise, owing to the elasticity of their valves. Seeds of *Desmanthus virgatus* are much used for bracelets, ornamental baskets, &c.; they are of a rich glossy brown colour. *Ben* or *Bhen seeds* are from Moringa pterygosperma; from them the oil so called is procured (already mentioned at p. 37); the decorticated seeds (likewise exhibited), as well as the young pods, are eaten in curries in the East Indies, and much relished by the coolies; the wood is said to yield a dye. A bag of the nuts of *Aleurites triloba*, affording the best artists' oil. *Soap-berries* are the fruit of *Sapindus Saponaria*, well known for its detergent qualities, used also for poisoning fish; Indian Shot, the seeds of *Canna Indica*, from the tuberous roots of which, and from the other species of *Canna* the esteemed farina called *Tous les Mois* is

made. *Cocoa-nibs*, the seeds of the *Chocolate Tree* (Theobroma Cacao.) Leaves of the *Bread-nut* (Brosimum Alicastrum); the branches afford an excellent fodder for horses. *Avocado Pear* (Persea gratissima); a delicious fruit, whether eaten with sugar and wine, or cooked as a vegetable. The seeds contain so much tannin, that a cloth stretched over one of them and pricked through with a pin, becomes marked as indelibly as by Permanent Ink; the fruit in decoction yields a quantity of fatty oil. The *Achras Sapota*, of which the fruit is called *Neesberry*, yields abundantly a milky substance like Gutta Percha; the fruit is delicious, superior in flavour to Medlars; the seeds are said to be a valuable diuretic in cases of strangury, and the bark has been employed as a substitute for Cinchona. The *Sweet Sop* and *Sour Sop*, from both of which a Starch is manufactured, are species of Anona. Of *Pulse* there is a considerable variety; the *Pigeon Pea* is the seed of Cajanus bicolor, and is much used when green as a vegetable, and in a dried state for soups; several species of Dolichos and Phaseolus are palatable. There can be no doubt that the climate of Jamaica is very favourable to the growth of Beans and Peas, and that an ample return would be yielded by their culture. *Starch* is exhibited from the *Zamia*, *Cassava* (Jatropha), and from Ipomæa Horsfall; the latter plant, which produces a beautiful many-coloured Convolvulaceous flower, has an enormous tuberous root, affording as much as from 20 to 50 lbs. of starch, which deserves to be carefully analysed; the root of an allied species yields the *Medicinal Jalap*. The *Mango* (Mangifera) likewise affords pure starch in considerable quantity, and a spirituous liquor may be extracted from it. *Plantain Meal* (from Musa Paradisiaca) is of a highly nutritious quality, and easily obtained by grating the sliced pieces of the plantain, after drying them in the sun. (The value of this plant, for fibre, has been already noticed, p. 37.) Other kinds of *Meal*, from *Maize*, *Coco*, *Bread fruit*, *Pumpkin*, *Sweet Potato*, *Guinea Corn*, *Yam*, &c., are exhibited; that from *Hibiscus esculentus*, commonly called *Ochro Powder*, is highly esteemed; it adds a glutinous richness to soups and stews. The *Congo Pea Meal* (a species of Cajanus) is also much used. *Arrow-root*, prepared from the tubers of Maranta arundinacea, is too extensively known, and the West Indian Arrow-root is too universally acknowledged to be the best, to require further notice. One point may, however, be mentioned: it is customary in Jamaica to test its purity by the simple way of dropping a pinch of it in a tumbler of water and stirring it quickly; if the powder subsides almost immediately, leaving the water clear, the arrowroot is good; but if

Arrow-root; how to test it.

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Jamaica.

the water remains milky, the powder is adulterated. *Cassareep*, used to flavour sauces, is made from *Cassava* (Jatropha Manihot) by boiling down the poisonous water in which the root has been washed; the deleterious principle is Prussic acid. The native practice of poulticing sores with the fresh grated root of *Cassava* is of doubtful utility; it has been known to prove highly injurious. Of *Snuff*, *Tobacco*, and *Cigars*, I need not speak: they are exhibited in great variety and profusion. *Ginger*, whether preserved or dried, or in essence, is an important article of export. Gouania Domingensis, called *Chew Stick*, affords an excellent dentifrice, and *Hogberry bark* (the botanical name unknown) a valuable astringent.

Tobacco, &c.

Castor Oil, *Cocoa-nut Oil*, and *Oil of pepper* (Capsicum cerasiforme) are among the principal oils; the latter, in the state of essential oil, is so powerful, that one drop suffices to flavour a whole tureen of soup. The *Artists' Oil*, from the nuts of Aleurites triloba, and the *Ben* or *Bhen Oil* from the seeds of Moringa pterygosperma, have been already noticed; the latter is particularly valuable for lubricating the delicate machinery of clocks and watches, as it neither corrodes nor freezes.

Gums; some medicinal.

Gums are chiefly from the *Cedar* (Cedrela odorata), the *Cashew* (Anacardium occidentale), and the *Hog Gum* (Moronobæa coccinea): the two latter possess medicinal qualities; the *Gum Birch* (Bursera gummifera), and *Logwood* (Hæmatoxylon Campechianum). The *Aloe perfoliata* affords an extract, said to be preferable as a purgative to the *Barbados Aloe* (A. socotrina.)

Preserves, Pickles, and Liqueurs complete the series; the former are chiefly from Guavas, Pine Apple, Papaw, Limes, Oranges, Tamarinds, and Ginger; the pickles are Cucumbers and Capsicums, and Pepper; the liqueurs from Prune bark, &c.

In this Class a Silver Medal was awarded to Messrs. W. Berry, Ellys, and Crestwidge, and to the Society of Arts, Jamaica, and to Mr. N. Wilson; and a Bronze Medal to Mr. Edwd. Chitty.

British Guiana.

IV.—BRITISH GUIANA.

(Special Commissioner: W. H. (since Sir Wm.) Holmes, Esq.

British Guiana collection valuable, and its catalogue useful.

This collection occupies, in the *Annexe*, a space adjacent to that of Jamaica, to which it is a worthy pendant, not only as regards the collection itself, but the Catalogue. The latter is executed with great care, and does credit to the compiler, whose name does not appear, displaying consider-

able research, and an amount of scientific knowledge which would not have been found in any of our colonies a few years ago. It is entitled a "Catalogue of Contributions transmitted from British Guiana to the Paris Universal Exhibition, 1855, 8vo., printed for the Guiana Executive Committee, at George Town, Demerara." It is accompanied by an excellent Sketch Map of British Guiana, 1840, and a Map of the settled districts of British Guiana, 1846, (both by Sir R. Schomburgk), and a Meteorological Diagram of daily Means for ten years, by P. Sanders. Forty closely printed pages are devoted to a brief History of British Guiana, especially in relation to its commercial interests. Of these, 13 (Section A.) relate to Saccharine Products and articles, among which are fully discussed whatever relates to Sugar, its cultivation and preparation, Rum, Rice, Coffee, the various Starches or Farinaceous substances derived from the Sweet and Bitter Cassava, Common Yams, Buck and Guinea Yams and Arrow-root, Zamia, Sweet Potato, Tous les Mois, Plantain, and Banana. Section B. discusses Fibrous substances; the fibres of Plantain and Banana and of the Manilla Hemp (Musa textilis) and Cotton. Section C. is devoted to Chemical and Pharmaceutical subjects. Section D. to Woods for building and other purposes; Section E. to Indian manufactures and miscellaneous articles; and Section F. to Natural History, chiefly Zoology.

The rest of the work is occupied by a List of the objects exhibited, and remarks upon them, arranged according to the above Sections. Hence it will be seen that the British Guiana Collection abounds in Vegetable Products, and is peculiarly rich in raw materials. It is my duty to limit myself, as much as possible, to native, or uncultivated, or only partially cultivated articles; and my observations will be the briefer, as many of these are (as might be expected) found equally in Jamaica, and have been therefore already discussed.

SECTION A.

Saccharine Products and Articles of Food.

British Saccharine and esculent products of Guiana.

This head comprises but few objects belonging to Class II. We may mention *Arrow-root* from Maranta arundinacea, L.

Cassava, *The sweet* (said here to be Janipha Loeflingii); the root sliced and dried is good food.

Banana, the unripe fruit of Musa Sapientum, is also eaten sliced and dried.

Plantain (Musa Paradisiaca). The meal made from its unripe fruit is called Conquin Tay.

Sir W Hooker on Vegetable Products.

British Guiana.

Cassava, the inspissated juice of the Bitter Cassava, has already been noticed under the products of Jamaica. In Guiana it forms the basis of the well-known *Pepper-pot*, and has a valuable antiseptic property of preserving meats from decay.

Tannia, or *Yellow Hog Meal*, is made from the root of a Caladium (Colocasia sp. ?)

Ochro is the name given to the dried capsules of Hibiscus esculentus L. In the colony it is customary to put the young capsules of this plant into soups, as they have a highly nutritious quality; and it is suggested that the following mode of preparation would render them available at all seasons, and would allow of their exportation to great distances. The *Ochro-pods*, or small green capsules, should be chosen from the top of the stem and before any woody matter has formed in them; they should be cut across, severed from the hard calyx, spread in the sun, and turned over till dry, when they may be closely packed in casks or tight cases: an oven will serve as well as exposure to the sun.

Black Pepper (Piper nigrum) thrives so well in Guiana, that a single vine (or plant) yielded to the exhibitor a crop of 10 lbs. weight in one season.

Starches are contributed in a considerable series, viz.:

Sweet and Bitter Cassava.

Common, Guinea, and Buck Yams.

Arrowroot.

Tannia. (Colocassia).

Sweet Potato or Batatas.

Plantain. In this last case it is the unripe fruit, and not the roots, which afford the starch.

SECTION B.

Fibrous Substances.

Fibres: those of Plantain stem, and others.

Plantain Stem (from which the fibre is obtained) is highly prized by coopers in the raw state. Of the *Plantain Fibre* numerous fine samples are exhibited; they are prepared in various ways, and dressed by steeping or otherwise. Some are procured by splitting the stem into pieces, and scraping it with a blunt cutlass. Others are severed and cleaned at one operation by the machine of Messrs. Burke and Burns, of Montserrat.

Plantain rope is manufactured from the fibres of the fruit stem, and twisted by hand; it is coarse and brown.

Plantain stem, undressed and made into rope, obtained a prize at the Georgetown Exhibition.

Banana rope is made from the fruit stem of Musa Sapientum, also from that of the Dwarf Banana (Musa Sinensis?)

Musa textilis: its dried leaves, from Georgetown. This plant affords the *Manilla Hemp:* growing plants of it, probably the first ever introduced to the New World, were carried to Guiana from Manilla by D. Shier, Esq.

Silk grass, or *Corawa*, is the fibre of a species of *Bromelia.* It is much less abundant than Plantain fibre, but of better quality, and is so strong that the Indians prepare it for Bowstrings, Nets, Fishing-lines, and Cordage. N.B. It is a matter of regret that the scientific appellation of such a useful plant should be thus unknown, which would not be the case if the exhibitors had sent flowering specimens of the plant itself for verification in Europe. Ten other samples are exhibited under the same name, and equally with no means of determining the exact species.

Aloe Fibre (said to be derived from Agave vivipara), very good.

Ochro the *Wild* or "*Jumby*" (a species of Urena?)

Mahoo (or *Mahoe*). Said to be the fibre of Thespesia populnea or Hibiscus elatus. L. Fibre undressed. These names need confirmation, or rather correction, two genera being here assigned to one object. This obscurity is the more to be regretted, as to nine different articles the name of *Mahoe* is given; but, of which of the two above-named plants is Mahoe the product? The Bark (Article 39,) which is coarse and brown, was used for the envelope of cigars. "The fibre of *Mahoe* is very strong, and employed for making coffee-bags."

Ita Palm (Mauritia flexuosa, L.) The fibre is stated to be excellent and the plant is extremely common in the Swamps The Indians prepare a beautiful cordage from it, of which they weave their hammocks.

Oohu Tree. Rope is made from the bark. No name or further notice of properties.

Kinwa. Rope is made from the bark. No name or further notice of properties.

Cucurit, or Koquerit Palm (Maximiliana regia, *Martius*). From the flower-sheath a rope is manufactured. This ornamental Palm is to be found in large numbers in almost all parts of Guiana, growing as well in the high as in the low lands. "From the ashes of the burnt midrib of the leaf "the Accawai Indians obtain a substitute for salt."

Nibbie. A bush-rope, with which the leaves of the *Troolie Palm* (Manicaria saccifera), used as thatch, are secured.

Silk-cotton, the *Comaca* of the Indians, is the soft, short, copious silky fibre which surrounds the seeds within the pods of *Bombax Ceiba.*

Sir W. Hooker on Vegetable Products.

British Guiana.

SECTION C.

Chemical and Pharmaceutical Articles and Products.

Chemical articles (not all correctly named):

(Many of them, especially the *Tanning Substances*, require to be tested, and the names of the plants which yield them to be carefully ascertained.)

Oils,

Crab-oil, obtained from the seeds of Xylocarpus Carapa (Carapa Guianensis *Aubl.*) is much burnt in lamps, and also esteemed for the hair. The tree is called *Crab-wood* in the Colony (a corruption, doubtless, of *Carapa*).

Laurel oil is considered to be produced by Oreodaphne opifera, *Nees*. It is extensively used by the natives in affections of the joints, and has proved to be an admirable solvent of India-rubber.

Balsam of Copaiva, from the Berbice River. Many different Trees in the Colony are supposed to yield this Balsam, but they are not yet botanically determined.

Vinegar is obtained by throwing ripe *Bananas* (the fruit of Musa Sapientum) into baskets, which are supported on open barrels. The juice drains into the latter, where it quickly ferments and becomes acid, without any addition of water.

Birambi is the fruit of Averrhoa Bilimbi, L. It makes an excellent pickle and a delicious preserve.

Hya-Hya-tree, otherwise called *Cow-tree* (Tabernæmontana utilis), affords a thick and sweet milky fluid, which contains caoutchouc. A decoction of its bark is used by the Indians in the cure of a malignant ulceration of the rectum, peculiar to those people. The disease is called by them *Carabisi*.

Ducali-tree (its botanical name unknown), which grows on the Berbice river, yields a medicinal milk, of a similar nature to that of the *Hya-hya*.

Curawatti, a juice used as ink, from the Berbice; its origin not ascertained.

Wallaba Gum (Eperua falcata) is said to be useful in fresh cuts and wounds.

Poisons,

Wourali or *Ourali Poison*. This famous poison, from the Pomeroon River, consists chiefly, according to Schomburgk, of the *Strychnos toxifera*.

Ooroobo Poison (alleged to be obtained from a plant resembling the *Tannia* or *Colocasia* or *Caladium*) is far more deadly than the Wourali, causing death by a single inhalation. The Indians treacherously employ it to accomplish their revenge, often during their feasts and dances.

Gum-resins,

Gum-resin of the Simeri tree (Hymenæa Courbaril) is obtained by digging near the roots, where the substance may be found in pieces, a foot long; or it exudes in masses when the

tree is tapped. It is the *Gum Animi* of Guiana (not of commerce,) and is used in the Colony, where it is very abundant, as Gum Copal.

Gum-resin of Conima, from the *Hyawa* or *Incense tree* (Icica heptaphylla) is highly flagrant, and suitable for pastilles.

Gum-Karman, or *Buck-wax*, is the inspissated juice of the *Mani-tree* (here said to be), a species of Amyris, or Icica. It is employed by the Indians to preserve their nets and cordage, as we should use pitch.

Gum Curakai, or *Kurukai*, mixed with Annotto. The Indians paint their faces with it. The Annotto is the viscous pulp surrounding the seeds of Bixa Orellana.

Turmeric, the roots of Curcuma longa. No country yields such good Turmeric as Guiana.

Greenheart, also *Sipiri*, or *Bibiru tree* (Nectandra Rodiæi.) Its seeds are a tonic and febrifuge. In times of scarcity the Indians grate these seeds, and eat them, mixed with decayed *Wallaba* (the wood of Eperua falcata.) The bark, too, affords the well-known alkaloid called *Bibirine*, which is a febrifuge. *Sulphate of Bibirine* is exhibited.

Guinea-pepper or *Grains of Paradise*, the seeds of Amomum Melegueta, are much superior to those imported from Africa.

Physic Nuts (Jatropha Curcas, L.) are emetic and purgative, and much used by the blacks.

Cow-Itch, the pods of Mucuna pruriens, are a well-known Vermifuge.

Pink-root (Spigelia Anthelmintica), the fresh leaves and stems of this species are a more energetic and certain vermifuge than those of the common *Pink-root* (S. Marilandica, L.) From eight to ten leaves, carefully separated from the injurious seeds, washed and boiled in as many ounces of water, afford a certain cure for worms, when followed by a dose of castor-oil. Medicinal barks, &c.

Lemon Grass (Andropogon Schœnanthus, L.) is a specific for the low fevers of Guiana: its hot infusion affords a fragrant and grateful sudorific. *Liquorice* (so called) is the Abrus precatorius: the seeds are known under the name of *Crab's Eyes*: a decoction of the foliage is taken for Influenza.

Toyo (Justicia pectoralis). An infusion and syrup of this fragrant plant is strongly recommended as a cure for chronic coughs.

Bociarie is the stem of an unknown plant, which abounds in the interior of the Colony, and is a favourite remedy among the Indians for pectoral complaints: it is exceedingly bitter, and a good stomachic.

Simaruba bark (Simaruba officinalis), a well-known anti-dysenteric.

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Sea-side grape Bark (Coccoloba uvifera). A strong astringent resides in the leaves, wood, and bark; a decoction of which, prepared by evaporation, forms *Jamaica Kino* (according to Lindley's *Flora Medica*).

Quassia or Bitter wood (Quassia amara) is distinct from the Quassia of the shops, and is abundantly employed in the Colony as a tonic and febrifuge.

Citric acid is obtained from the fruit of Citrus Limetta: the tree grows almost spontaneously throughout Guiana, and bears abundantly.

Wangala, the seeds of Sesamum orientale: when parched and pounded, they make a rich soup; expression brings out a fine bland oil, and a mucilaginous drink is prepared from the fresh steeped leaves.

Ubudi, or Wild Cashew Bark, is a powerful astringent, and effects wonderful cures when applied warm to sores.

Soap-wood Bark (Sapindus Saponaria), also called *Hurawassee* by the Indians, is employed as a substitute for soap; taken internally it is an emetic.

Mora Bark (Mora excelsa) is useful for tanning. A warm decoction heals ulcers very rapidly, and the seeds, which contain much starch, are eaten by the Indians in time of scarcity.

Queiche Bark is said to be useful in dysentery; the scraped inner bark should be mixed with water, which is thus rendered slimy.

Cretti Bark is esteemed by the Indians as a remedy for cramp in the stomach.

Sarabadani Bark affords an excellent dressing for foul ulcers.

Darena Bark and *Iturissi Bark*, taken in decoction, are strong emetics.

Turanira Bark is a powerful diaphoretic, and *Cabacalli bark* a good dressing for sores. It is much to be regretted that the trees which afford the above-named seven barks, which all seem to possess valuable medicinal qualities, are unknown. The barks of the *Mangrove*, the *Hog-plum* (Spondias lutea), the *Karakalli* (Lecythis ollaria), and the *Siruaballi* (Nectandra sp.?), are all recommended for *tanning*. Also the following Barks, of which the scientific names, and consequently the trees which produce them, are undefined: *Baramalli or Pump-wood Bark, Marsiballi, Hurahee, Arumata, Konaballi, Cuyama, Kulaballi, Siruaballi, Haiawaballi*. The *Kuruhuru Bark* is also anemetic. The *Arrara*, besides being useful for tanning, is an emetic, and is employed by the Indians to poison fish.

The *Pacuri Bark* affords a lotion for the *Carabisi* (the before-mentioned disease of the rectum), and the *Blood-wood*

Bark, or *Urali*, is used by the Indians to remove films from the eye.

Finally, we have *Duca Bark*, *Baracara Bark* and *Barrowa Bark*, the properties of which are not specified.

SECTION D.

Woods, for Building and other Purposes.

The contributors of this collection say, and with much justice, "We may unreservedly assert that, in this branch, "the natural productions of our Colony equal those of any "part of the world. Two prizes were awarded to our Tim- "bers by the Juries of the Great Exhibition in London "1851." The kinds enumerated, and of good-sized specimens, amount to upwards of 100 exclusive of a supplementary Catalogue of 15. "This List," they say, "might be greatly "increased by the addition of many well known and much "used Woods; but their names in the colony being merely "the Indian ones, would convey little information, as most of "them are still undescribed, and the trees whence they are "taken are not yet botanically determined." However this may be, and there is perhaps some little mistake in the latter assumption, one thing is certain, that the colonists of Guiana would render a great service to science, and a still greater one to their own interests, by sending to the Royal Gardens, Kew, good samples of all these different and especially less known woods, accompanied by specimens of the branches and foliage, and, if possible, the flowers also, of the trees; the wood and the specimens to be marked with corresponding numbers. The exact genus and species of each, could then be determined; and authentically named specimens would be deposited in the Kew Museum of Economic Botany, for the information of all inquirers. The eminent Traveller and Naturalist, Sir Robert Schomburgk, has thus elucidated the Woods of British Guiana:—

Woods of unequalled excellence,

but not all correctly named,

"The fitness of the timbers for naval architecture is remarkable; some are said even to excel the Teak. The *Greenheart*, the *Mora*, and the *Souari* are, of all the woods the best adapted for shipbuilding. Within the last twelve years a large quantity of the *Brown Greenheart*, has been sent to Liverpool and Greenock; and I am told that persons there interested in shipping have pronounced it, after ten years' trial, to be superior to Oak for strength and durability. It actually commands a higher price.

useful for ship-building; Sir R. Schomburgk's opinion of them.

"Had these Woods been known, and extensively used in the Royal Dockyards, fifteen or twenty years ago, it is the opinion of competent judges that dry-rot and Kyan's Patent

would not have been much heard of. And, not to speak of the rapid decay of vessels built of English and African oak, and the consequent repairs, how great would have been the saving to Government? If, therefore, the attention of the Navy Board could be drawn to the important fact, that British Guiana is able to furnish the finest and most lasting timber in the world and in quantities sufficient to supply all the ship-building establishments in Great Britain, a double benefit would ensue, namely, the saving to Government and the increased demand for an important production of our own Colony." The first experiment might be to found a Dockyard for the repairs of such of Her Majesty's cruisers on the West India Station as do not draw more than 18 or 19 feet of water. The outlay of such an establishment would be trifling, compared with its importance, if ultimately successful."

Baracara (Erythrina Corallodendron). A hard, close, and even-grained wood. The seeds of this tree are large and red: necklaces, &c. are made of them.

Wallaba (Eperua falcata). A deep red, hard, and heavy wood, which splits well, and is much used for building. The resinous oil which it contains renders it very durable, and a roof well shingled with it resists weather, and will last for forty years. The tree is abundant, and yields timber forty feet long and a foot and a half square. The bark and gum are already noticed.

Kakaralli (Lecythis ollaria). An abundant tree, affording a straight, hard, and durable wood, which resists the attacks of sea-worms even better than the *Greenheart* does, and is therefore much prized for wharves, &c. The bark is easily separated by beating; and the layers, of which Schomburgk has counted 70 in a single strip, are as thin as satin-paper, and are employed, when dried in the sun, for enveloping cigars.

Cumaramara or *Marmalade Tree* (Lucuma mammosa) affords a hard, tough wood, of which pestles are made, and a delicious fruit, which tastes like marmalade.

Bartaballi (Lucuma Bonplandii). A large and plentiful tree, of which the white and rather light wood is used for the inside work of houses: it bears an agreeable fruit.

Siruaballi (Nectandra or Oreodaphne) grows very large, but is apt to become hollow with age. The bitter principle resident in the wood makes it resist the attacks of worms, for which reason it is used for the outside planking of boats. It serves, too, for masts and booms. There are four varieties of the *Siruaballi*—black, brown, yellow, and white; the last is the least valuable.

Sipiri, Bibiru, or *Greenheart* (Nectandra Rodiæi), the *Yellow variety.* A fine Tree, affording most valuable wood: the timber squares from 18 inches to 2 feet, and often measures 70 feet without a single knot. For Ships, Bridges, House-frames, and all purposes requiring strength, resistance to pressure, and durability, the *Greenheart* is unsurpassed. At Lloyd's it is now ranked, along with the *Mora* (*Mora excelsa*) as one of the eight first-class woods for ship-building. The *Black variety* is even more durable, and takes a higher polish: the only main difference is in colour, and the *Black Greenheart* is very rare, and does not attain quite so great a size as the *Yellow.* The seeds and bark are noted under Section C.

The Greenheart,

Mora (Mora excelsa) has already been mentioned (*see* Section C.) for its eatable seeds and valuable bark; also, in conjunction with the Greenheart, as a most important timber for ship-building, and recognized as such at Greenock and in Lloyd's List of Woods. The tree towers above all others in the forests of Guiana, attaining to 100 to 150 feet, often unbranched for half that height. The wood is tough, close, and so hard to rive that it can hardly be splintered by cannon-ball, and would thus be invaluable for men-of-war. It is very abundant on the banks of the Parima river, whence the facilities of transport are great (an important circumstance when estimating the value of timber), and also grows along most of the rivers in the Coast region. The *Mora* has an advantage over Oak, in not being liable to dry-rot. Schomburgk writes, that often, when navigating the Parima, he saw on a distant point hillocks of verdure, which he supposed to be groups of trees, but found, on a nearer approach, to be only a single *Mora*, 130 to 150 feet in height, and forming a perfect forest of vegetation. Indeed, taking the valuable timber, the medicinal bark and seeds, and the facilities of transport all into consideration, no Guiana tree is of such importance as the *Mora.* (The British Government is now directing its attention to the utility of the *Mora Trees* of Trinidad, which have lately been brought into notice by Mr. Purdie, the Colonial Botanist there.)

and Mora, are the best timbers of British Guiana.

Crab-wood (Xylocarpus Carapa, or Carapa Guianensis). A plentiful tree, affording timber 50 feet long and 15 inches square, which is light, takes a good polish, and makes excellent furniture, &c. It is used, too, for masts, spars, and shingles. The seeds yield *Crab-oil* (*see* Section C.), and the bark is useful for Tanning (both the oil and bark are noticed in their places), so that the tree is among the most valuable in the colony.

Warracoori or *White Cedar* (Icica altissima) is abundant in low grounds, and yields a light, aromatic, and easily wrought wood, well fitted for Oars, Paddles, Canoes, and inside work of houses. The bark is used in decoction for the Indian malady called *caribisi*, already mentioned. A red variety of this tree, called *Red Cedar, Carana*, &c. grows nearly 100 feet high, with a diameter of four or five feet, and is preferred by the Indians to all other timber for their canoes, as it is easily worked, and not liable to split. One of Schomburgk's canoes, hollowed out of a single trunk of *Red Cedar*, measured 42 feet long by 5½ feet wide; and though not new when he bought it, and used by him for four years in salt water and fresh, as well as being hauled over land and cataracts, it was perfectly sound at the end of the Expedition.

Maniballi or *Candlewood* (Icica sp. or Amyris) is a straight-growing tree, affording hard, close timber, and the wax called *Karman* or *Curi-mani* (*see* Section C.), with which the Indians fasten their hooks and arrows, &c.

Bourra-courra or *Paira*, more commonly known as *Letter-wood* and *Snake-wood* (Piratinera Guianensis or Brosimum Aubletii). A tree, very scarce near the coast, but plentiful upon the rivers Rupununi, Essequibo, and Corentyne, places distant from the settled districts of the colony, and whither the wood is brought at much cost and difficulty. It is sold by weight, and fetches 8*d.* per lb., being very beautifully marked and spotted with small black streaks, which give rise to its name. The ground colour is red; the heartwood is the variegated part, and it takes a fine polish. The use of it is limited to veneering picture-frames and small pieces of furniture; it is formed into bows by the Indians, more for ornament than service, and the colonists make walking-sticks of it.

Simeri or *Locust-tree* (Hymenæa Courbaril). A tree of frequent occurrence in Guiana, which often attains to 60 or 80 feet unbranched, and has a diameter of 8 or 9 feet. The wood is esteemed for furniture, being close-grained, of a rich brown, and beautifully streaked, capable of a fine polish. Its non-liability to split or warp recommends it for machinery, and it is used in England for steam-engines. The negroes eat the farinaceous saccharine pulp of the seeds, and make canoes of the Bark. Its resin (*Gum Animi* of the Colony) noticed in Section C.

Dali or *Dari* (Virola sebifera) grows to a large and majestic tree on the river-banks: the wood is light, and splits freely, and the oil from the seeds is alleged to make candles equal to wax.

Itikiburi or *Corkwood* (Drepanocarpus lunatus?) Abundant near rivers and creeks; the wood serves for floats in fishing, and the fresh bark imparts to uncoloured Rum the hue of Brandy.

Simaruba (Simaruba amara) grows on hillsides to 50 feet high, with a wood like White Pine, light and easily worked, and well adapted to inside fittings.

Buruch, *Bully*, or *Bullet Tree* (Mimusops sp.) Abundant in Berbice, very large, and abounding in a milky juice, which exudes from the trunk, branches, and foliage. The wood is dark brown, variegated with white: it is solid and durable, much used for house-framing, and prized, as the weather does not affect it, for the shafts, arms, &c. of windmills. It squares from 20 to 30 inches, and may be obtained from 30 to 60 feet long, the whole tree measuring sometimes above 100 feet; but it has the disadvantage of being attacked by worms if exposed to salt or brackish water. Its bark, in decoction, is efficacious in curing an internal disease called *Quata*, which affects the Indians in the dry season. Its fruit is the size of a coffee-bean and very delicious. A Tree named *Ducaria* resembles the Bullet-tree in appearance and properties.

Itaballi (Vochysia Guianensis), 30–40 feet high, and 3–4 feet in diameter. The wood is perishable if exposed to weather, but being soft is much used by the Indians for their corials, also for oars, inside work, &c. The flowers are of a beautiful yellow, highly fragrant, and very ornamental.

Coopa (Clusia insignis). A parasite, growing over the tops of the loftiest trees, whence it sends its roots, sometimes half a foot thick, to the ground. The wood is hard and dark brown, and the flower white, beautifully marked with blush and primrose. The fruit looks like a Spanish Onion, and is a powerful irritant to the skin; the seeds are the favourite food of the Powi-bird (*Crex Alector*), and impart a strong garlic flavour to its flesh.

Mariwayana or *Purpleheart* (Copaifera pubiflora and C. bracteata). There are several varieties of this rather scarce Tree, which all possess great strength and elasticity, and are peculiarly adapted, for this reason, for the carriages of cannon and mortars. The *Purpleheart* and *Black Greenheart* were the only woods which were found sufficiently strong for this purpose at the siege of Fort Bourbon, in the Island of Martinique. For the shafts of windmills, for turnery, &c., it is valuable, and the fine colour is equal to Rosewood. Its Bark is prized by the Indians for making canoes, which will carry 20 or 25 persons in smooth water. For one of these canoes, see Section E.

Wadaduri or *Monkey-pot* (Lecythis grandiflora). A tall, straight tree, of close, hard-grained, handsome wood, adapted for furniture.

Yari-Yari or *Yellow Lancewood* (Duguetia Quitarensis). This tree is slender, but its wood is remarkably tough and elastic, and in great repute for gig-shafts; the small branches serve for fishing-rods and whip-handles, and the Indians tip their arrows with the wood. The *Black Lancewood*, a variety, is quite as good.

Ita Palm (Mauritia flexuosa). The loftiest of the Guiana Palms, sometimes 100 feet high: its fibre is valuable, and serves many purposes, shields are woven of it; and an intoxicating drink, quaffed by the natives in their dances, is made from its fruit.

Cucurit or *Koquerit Palm* (*Maximiliana regia*). A plentiful tree, about 40 feet high, bearing an excellent fruit, of which the hard seeds yield a fine clear oil by bruising and boiling. If the seeds are kept they are almost invariably found to harbour a large larva, which ultimately perforates the flinty shell, and emerges through a circular opening. The undeveloped foliage constitutes a delicious cabbage, which is sometimes eaten in pickle.

Hya-Hya or *Milk Tree* (*Tabernæmontana utilis*) is a light, soft wood: its milky juice is already mentioned in Section C.

Wourali or *Ourari* (Strychnos toxifera. See Section C.) A hard, close-grained, cedar-brown wood.

Yaruri, *Massara*, or *Paddle-wood* (Aspidosperma excelsum). The trunk, which rises to 50 feet before it branches, and is 5 or 6 feet thick, is singularly fluted and buttressed, like a Gothic pillar of many clustered columns. Of these projections the Indians make paddles and axe-handles, the wood combining hardness and strength with lightness and elasticity. It would probably be found useful for the floats of paddle-wheel steamers.

Acuyuri (Astrocaryum aculeatum). A palm, of which the lofty trunk is covered with long prickles; the woody part is hard, takes a good polish, and is used for cabinet-work, &c. The fruit, about the size of an egg, contains a large seed, covered with a pulp which affords a bright yellow eatable oil.

Tonka Bean or *Cuamara* (Dipteryx odorata). Not plentiful: the wood is so tough and durable that it is said to have been tested, and found to bear 100 lbs. more weight on the inch than any other Guiana timber, and it is therefore peculiarly adapted for shafts, mill-wheels, and other uses requiring resistance to great pressure. The seed is the well-known Tonka Bean, used to scent snuff.

Haiawaballi (Omphalobium Lamberti). *Zebra-wood*, highly prized by cabinet-makers for its great beauty, is procured from the heart of this tree, which, though very large, seldom squares more than 10 or 12 inches.

Logwood (Hæmatoxylon Campechianum) is too well known to require remark. A variety called *Blood-wood* grows also in Guiana.

Cartan, from the Demerara river, is a very rare wood, and of a beautiful rich orange colour. It is conjectured to be the produce of a tree described by Schomburgk, and probably Centrolobium robustum of Martius. The height, 80 to 100 feet, the beautiful red colour of the wood, and the facility with which it is worked, promise to render it of great importance for cabinet-makers. Schomburgk used it, when in Pirara, for temporary tables; and a bridge across the river was constructed of its large planks. The leaves are impari-pinnate, the flowers papilionaceous, and the fruit a samara, with a prickly capsule, the wing being four or five inches long.

Itikibourraballi or *Tigerwood* is Machærium Schomburgkii. Its rich brown spotted wood, like a leopard's skin, is very beautiful.

Souari (Caryocar tomentosum). A durable timber, very like Mora, of large size, and equally adapted for ship-building.

Camara or *Accawai Nutmeg* (Acrodiclidium Camara). Trunk 60 feet high and 8 to 10 feet in girth. The timber is aromatic and bitter, and resists insects.

Lana (Genipa Americana). Very lofty, and with a trunk which squares from 14 to 18 inches: valuable for its closeness and strength.

Courida (Avicennia nitida). A tree of surprisingly rapid growth. The wood is durable under ground, but perishable when exposed to the air.

The preceding list contains all the Woods in the Guiana Collection, of which the botanical names are given. The rest only bear the native appellations, under which it is probable that more than one kind is often confounded with another, affording of course no correct clue to the trees which produce the specimens, especially as the different tribes of natives often have entirely different names for the same wood.

Kaieeriballi and *Bahuradda*. Excellent woods for beams and rafters, &c.

Banga, *Bannia*, or *Ebony*, from Berbice. A large fluted tree, often faulty at the heart: the wood is black, heavy, and strong. Used for veneering and ornamental work, and by the Indians for war-clubs.

Cabacalli. A tall and straight tree, 40 to 50 feet long, and squaring from a foot to 18 inches. The wood is heavy, close-grained, and almost equal to the *Siruaballi* (Nectandra) for boat-building, being equally secured by its bitter principle from worms; it requires, however, to be fastened with copper nails.

Kisselala. A heavy, hard wood: the scraped bark is a good styptic.

Houbaballi. A light brown beautifully marked wood, which takes a fine polish, and is well adapted for furniture and cabinet work.

Marsiballi. A plentiful tree, of which the wood is durable when not exposed to weather, and therefore suited for beams and inside work.

Hurahee. Hard and close-grained wood. The fruit is like an olive, dark purple.

Suradani. Much used for canoes, for wheels, &c.; but its rich brown hue would recommend it for furniture. The tree is large and plentiful.

Adabadani. A light, open-grained wood, used for house spars: the fresh bark quickly causes vesication.

Sarabadani. A dark purple, hard, and close-grained wood, used for furniture.

Cucuritballi. The tree grows 20–40 feet high, and its hard durable wood makes excellent rafters.

Ducali. A tree less noted for its wood than its milky gum, which has medicinal properties.

Kurakai. An enormous and abundant tree, which yields a resin like that of the *Hyawa* (Section C.) The wood is proof against dry-rot, light, odorous, and much used for corials.

Crababalli. Wood hard, but little used: a decoction of its bark is an emetic.

Putti. One of the commonest Guiana trees, and easily distinguishable by its beautiful lilac flowers: the wood is soft, and of little value.

Hitchia. Very large and lofty: wood used for spars and rafters.

Turanira. Abundant, and so large, that planks of it, 40 feet long, will square more than two feet: the wood is hard, even-grained, and has all the good qualities of the Bullet-tree, except that it will not bear exposure to weather. The fruit is delicious.

Determa. Admirable for masts and spars, and for boat-building if copper nails are used. Insects will not touch it.

Cynthia or *Wild Allspice.* A tall and slender tree, with close-grained wood, like Box: the berries are used as a condiment.

Cacarua. Wood hard and compact, fruit delicious.

Curahuru. A tall, straight, and plentiful tree, valuable for all purposes requiring durability and resistance to strain. The Indians make canoes of it.

Tooroo Palm, 60 or 70 feet high: the woody outside is used for inlaid work, walking-sticks, &c.; and a drink like chocolate is prepared from the fruit.

Awara Palm. A small tree, 20 or 30 feet high, the trunk and leaves are covered with formidable prickles, which the Indians use for pins; they also make a favourite drink from the ripe fruit, and carve handsome rings and bracelets of its hard and very black nut.

Arumata. A hard, strong wood, adapted for planking vessels; the heart is pretty, and might serve for furniture.

Ducaliballi. A large but not plentiful tree, of which the deep red, close-grained wood is even compacter than Mahogany, and in great repute for turning and for cabinet-work. It is like and perhaps identical with the *Brazilian Beef-wood.* Another tree, called *Bastard Ducaliballi*, resembles it, but is inferior. A variety is called *Blood-wood.*

Cowassa or *Wild Mammee* is a hard, close, rich brown, and prettily waved wood.

Assepoca is a rare fawn-coloured wood, exceedingly hard and compact.

Moraballi. Very plentiful: the wood is hard and durable, and makes good beams and boards for building. The Indians use the young saplings, when beaten out so as to separate the fibre, for torches.

Warri. The Indians prize this rare, close, and rather handsome wood for canoes.

Wamara or *Brown Ebony.* A hard, cross-grained wood, not liable to split, and therefore peculiarly adapted for ship-building: it is one of the handsomest of Guiana woods, being dark brown and beautifully streaked. Its hardness and weight recommend it to the Indians for their war-clubs.

Hucouya or *Ironwood* grows 50 feet high and 6 feet in diameter: its reddish, dark, and uncommonly hard wood is easily damaged by wet.

Bisi. A gigantic tree, of durable wood, used by the Indians for canoes.

Siruba. A tree only found in the interior, of great size, and prized for ship-building.

Anapaima. Very large, and a close-grained wood.

Tataba. A very large tree: the wood is hard and tough, and used for mill-timbers, gun-carriages, and purposes requiring strength.

Washiba or *Bow-wood* Strong, durable, and elastic; the Indians make bows of it.

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Waranana or *Wild Orange.* A large tree, growing on river banks: the wood is used for oars and staves.

Hackia, also called *Lignum Vitæ.* Wood hard and valuable: used for furniture.

Coutaballi. A durable wood when protected from weather.

Saka or *Bastard Purpleheart.* Used for furniture.

SECTION E.

Indian (Native) Manufactures and Miscellaneous Articles.

Indian and miscellaneous articles, as hammocks, blow-pipes, &c.

Of these I can notice only such as serve to illustrate the uses of Vegetable Products. The Model of a *Buck-house,* or Native dwelling, exhibits the various implements and utensils of the Arawak Indians: another is a Model of an Indian Establishment of the Caribi Tribe.

Other articles in this Section are the implements and objects themselves.

Pagala, Pegali, or *Pagalio.* These are baskets, one within another, or a nest of them, made by the Arawak Indians from the Iturite, a jointed reed. They are of beautiful workmanship and design. One of the patterns is considered identical with the *Meander pattern* on Greek and Etruscan vases, which is seen also in Egyptian and Assyrian ornamentation.

Hammocks, of the fibre of the *Ita Palm* (Mauritia flexuosa), already mentioned under Sections B. and D.

Woodskin Shirt, made of the inner bark of the *Cumakaballi* by the Maiangong Indians.

Fishing-net of *Silk-grass* (*Bromelia?*). Noticed under Section B.

Suriana or *Hammock-Case,* made of the *Moucourou,* a jointless reed.

Sieves and *Cigar-cases, Bows* and *Arrows* and *War-clubs,* made by the Indians. The materials unknown.

Blow-pipe, with Quiver and Arrows. The former consists of an outer and inner tube; the former ornamented with Pegali work, the latter made of a single internode of Arundinaria Schomburgkii; these internodes are sometimes 16 feet long. The arrow is inserted into the tube, and sent flying by a sudden expiration. The Indians use different arrows for hunting, for shooting fish, birds, &c. A complete set consists of nearly 50 kinds.

Macquari Whips, made of Silk-grass and the fibre of the *Ita Palm.* The Arawak Indians use them at their funeral dances, and ply one another's legs with them till severe gashes and blood follow; this is done as a test how they can bear pain.

Mude-sticks, used to produce fire by rubbing them together: the wood is unknown.

Caps, of the spatha which encloses the unexpanded flowers of the *Troolie Palm* (Manicaria saccifera); they are made by soaking the spathe in water, and pulling and stretching it to the desired shape.

Winna or *Cigar-wrappers*, made of the *Manicole Palm* (Areca Manicot, Lodd. ?—an Areca oleracea?).

Woodskin or *Adada*, an Indian Canoe, made of the bark of the *Purpleheart* (Section D.), chiefly used for navigating small streams, though the natives sometimes shoot the rapids safely in these craft literally *barks*, and *fragile* ones too).

Fishing-rods of *Yellow Lancewood* (Section B.) and *Indian Torches* of *Moraballi* (Section D.), *Bowls* of *Greenheart*, *Bracelets* and *Necklaces*, of different seeds, &c., &c.

Broom, made from the midrib of the leaflets of *Cocoa-nut*, and a *Scrubbing-brush*, from a section of the nut itself, its fibrous covering serving as the brush, a handle being affixed to the end of the nut. No hair or whalebone brush acts better in accustomed hands.

Matapi, or *Cassava Squeezer*, of the *Moucourou reed;* it is used by the natives for expressing the juice from the grated Cassava.

SECTION F.

Natural History.

Under this comprehensive title all in our department migh properly fall; but the term is rather intended to include *odds* and *ends*, whatever does not rank in the previous Sections. Little of interest in our Class is found here; and that little consists of well known objects. The Parasitic plant from Canje Creek, which is known by the Indians as *Saka-hair*, and which grows in immense quantities on lofty trees, and is used by the natives to stuff pillows and mattrasses, is *Tillandsia usneoides*.

In this Class a Médaille d'Honneur was awarded to the Colony of British Guiana, and Honourable Mention to Mr. T. B. Duggin.

V.—CEYLON.

(Special Commissioner: Capt. H. L. Layard.)

The Catalogue of this collection (extending to 32 pages) is arranged under two primary heads, viz., A. *Raw Materials;* and B. *Manufactured Produce*. Each is divided into the *Vegetable*, *Animal*, and *Mineral Kingdoms*. From the

Ceylon collection: of considerable importance, but less valuable than it would

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Ceylon.

have been, if the catalogue were more carefully made out.

first, I shall select the objects which deserve notice. The collection, as a whole, is considerable; and a great number of the Vegetable products which it contained have been transferred, by gift or by purchase, to the Museum of the Royal Gardens, Kew. Many of the manufactured articles, especially of wood, are very beautiful. "The Cingalese collection was formed partly from private contributions, and was partly paid for with funds voted by the Legislative Council." The Catalogue is drawn up by Nietner; and it is justly observed by the Committee, that "it (the catalogue) will afford the agent in Paris an assistance that is almost indispensable, and will remain a useful record of the result of local efforts to promote the Imperial Commission, and, it may be added, a testimony to the resources of the Island."

The *Woods* and *Fibres* are numerous, the former especially so; and their relative weights or specific gravity, their properties and uses, together with remarks on their durability, are carefully noted and highly important: the samples of wood are, however, small, and the nomenclature is, I fear, frequently defective. It is a great pity that the services of the able Superintendent of the Botanic Garden of Peradenia were not called into requisition. All the Woods, indeed, are labelled with their native Cingalese names; and if these were accurate, and if the several names can be regarded as indicative of generic and specific differences, there are no fewer than 348 distinct kinds of timber; but, that such is not the case, is evident, from two circumstances:—one is the repetition that occurs, as for instance, Mr. Mendis' specimen of *Caha Milile*, No. 10, is named Vitex trifoliata, and his No. 54, labelled *Meean Milile*, is also called Vitex trifoliata; the second reason is that the woods or timbers are in two groups, the first 96 are collected by Mr. Mendis, Modliar, the rest, 250 in number, by Mr. C. P. Layard; yet no single individual of the latter corresponds in name with any one in Mr. Mendis' list.

As proofs of inaccurate nomenclature; No. 1, *Alubo*, is called Jambolana Calyptranthes. There is no such plant. Then comes Aponogeton crispum; but Aponogeton, far from being a tree, is a genus of small aquatic Herbaceous Plants. Choecarpus (for Elœocarpus?) pungens, Illicebrum latrum, Rhas dissipium, and numerous similar errors, occur; when the only really serviceable names are attempted to be given. The comparatively few that are accurately cited are common, as may be expected, to the adjacent country of India. Those most likely to be new convey no information to an European. Glad might we be to know the tree producing the *Caluvere* or *Ebony*, of which so much cabinet-work is

made; or the *Calamander wood*, a scarce and beautiful wood, the most valuable for ornamental purposes in Ceylon, and peculiar, it is believed, to that Island. The latter has been stated to be *Diospyros hirsuta;* but the catalogue affords no information on the subject. There cannot, however, be a doubt that Ceylon produces many woods equal in value to the *Calamander.**

A. Raw Materials.

Timbers.

Timbers: their weight and durability.

	Weight per cubic foot. lbs.	Average durability. Years.
Alubo (Eugenia, sp.); building houses	49	20
Aludel (Artocarpus pubescens); boats and buildings. The fruit (which is allied to the bread-fruit) is boiled and eaten	51	35-70
Andere (Vachellia Farnesiana); cross-bars of fishing boats, &c.	71	15
Arremene or *Sumatra Cassia* (Cassia Timorensis); furniture and buildings	57	50
Bairiye (?); buildings	57	10-30
Batte dombe (Eugenia, sp.); house building	45	20
Bely gobel (Paritium tiliaceum); palanqueens and hackeries	38	20
Burute. Satinwood (Chloroxylon Swietenia); oil-presses, wheels, bridges, building and furniture—a beautiful wood	55	10-80
Cadol or *Leafy Mangrove* (Rhizophora); grows chiefly at the mouths of rivers: wood used for building, and the bark to dye leather, nets, sails, &c.	65	40
Caha Milile (Vitex trifoliata); water casks, boats, wheels, &c.	56	15-80
Calu Keale (Butea frondosa); house building	38	30

* I suffer the above strictures to stand, because the Catalogue still remains in the defective state above described. Happily, however, Mr. Thwaites, the Superintendent of the Botanic Garden, to whom I have already alluded, has voluntarily come forward, and, while this Report is in the press, has corrected Mr. Mendis' List of Woods; and as Mr. Mendis has liberally presented a beautiful set of Cingalese Woods to the Museum of the Royal Gardens, Kew, with these amended names, I gladly adopt Mr. Thwaites' nomenclature, and acknowledge the scientific service he has thereby rendered.

	Weight per cubic foot. lbs.	Average durability. Years.
Calu Mediriye, Calamander-wood (Diospyros hirsuta); scarce and beautiful; the most ornamental wood in Ceylon	57	80
Calu Vere (Diospyros); *Ebonywood;* fine and black, used for furniture -	71	80
Cocatiye (Gambogia Gutta); house building - - - - -	56	30
Cottamba or *Almond* (Terminalia Catappa); house building; fruit eaten	38	30
Cos or *Jack* (Artocarpus integrifolia) timber much used for boats, buildings, &c.; fruit, weighing 5-50lbs., eaten - - - - -	42	25-80
Daminne (Grewia tiliæfolia) gun-stocks, &c. - - - - -	44	40
Daanga (Spathodea longifolia); buoys for nets - - - - -	23	—
Davette (Carallia Zeylanica); roofing -	42	25
Davol Kuroendoo (Litsæa Zeylanica); house building - - -	39	20
Del (Artocarpus pubescens) see *Aludel.*		
Diye parre (Wormia triquetra); house building - - - - -	44	20
Dige ratembela (Jonesia Asoca); house building - - -	58	25
Dombe (Calophyllum Inophyllum); masts and cross-trees of boats, &c. -	40	5-10
Doon (?); building - - -	29	50
Etteiriye (Murraya paniculata); handles of hammers, rafters, &c. - -	61	10-70
Gal Mendoon (Vateria, sp.); bridges and buildings; the best wood for under ground purposes - - -	57	15-60
Gal Morre (Amanoa, sp.); house-building; the best fire-wood for kilns; the berries are eaten by the natives - - - - -	65	30
Gode-parre (Wormia retusa); roofs of houses - - -	51	60
Gooru Keene (Calophyllum Calaba); poles for carts, &c. - - -	44	25
Hal (Vateria Indica); packing-cases, coffins, &c. - - - -	26	10
Hal Mendora (same as Gal Mendoon, —probably misspelt).		

	Weight per cubic foot. lbs.	Average durability. Years.
Hal Milile (Berrya Ammomilla); casks, carts, and houses; the best wood for making oil-casks in Ceylon - -	48	10-80
Hedde Woke (Chætocarpus purgans); house building - - -	58	50
Helembe (Nauclea parvifolia); house building - - - -	42	40
Hirrikaddol (Rhizophora, sp.); house building; bark yields a dye -	49	35
Horre (Dipterocarpus, sp.); roofs -	45	15
Hulanhick (?); buildings -	39	50
Hunukirille (Grewia paniculata); buildings - - - -	44	25
Kadoembeiriye or *Bastard Ebony* - (Diospyros, sp.); furniture - -	45	40
Kahatte (Careya arborea); axles for bullock waggons, &c. - - -	38	10-20
Kebelle (Scepa, sp.); house building -	40	20
Kette Kale (Bridelia spinosa); house-building - - - -	42	25-50
Kittoel (Caryota urens); wood used for window bars; the flowers yield the sweet and cooling drink called Toddy; it is also converted into Jaggery - - -	71	30-90
Kiripelle, or *Indian Fig Tree* (—?); furniture, and for building - -	30	20-30
Kiriwalla (Echites lanceolata); ornamental cabinet-work and inlaying -	35	30
Koang, the *Ceylon Oak* (Schleichera trijuga); wooden anchors and oil-presses; the berries are eaten by the natives - - -	49	5-10
Lawoloo (Sideroxylon sp.); building; the berries are eatable - -	39	10
Lunu Midelle, or *Bead Tree* (Melia composita); for building, &c. -	15	8-20
Madetiye (Adenanthera Pavonina); building; the red seed is roasted and eaten - - - -	56	30
Mahadan (Eugenia sp.); wheels, &c.; berries eatable - - -	36	20
Mal burute (Chloroxylon Swietenia). See *Burute* above.		

	Weight per cubic foot. lbs.	Average durability. Years.
Mee (Bassia longifolia); keels of boats, bridges, &c.; the nut yields a medicinial oil; the genus is the same as affords the vegetable butter of Africa - - - -	61	25-80
Meean Milile (Vitex trifoliata); see *Caha Milile.*		
Melle (Olax Zeylanica); house-building	64	40
Moone Mal (Mimusops Elengi); house-building and furniture - -	61	50
Morre, or Eye ball (?); building purposes, excellent firewood; the ripe berries are eaten - -	62	25
Murute (Lagerstrœmia Reginæ); water-casks and buildings - -	42	30-40
Naw, or *Ironwood* (Mesua Nagaha); bridges, &c. - - -	72	10-60
Nebede (Xanthoxylon Roxburghianum); buildings - - -	51	20
Nelly (Emblica officinalis); wheels, &c. for wells, as the wood is said to purify the water; berries are made into sweetmeats, and also used medicinally - - - -	49	30
Nendoon (Dalbergia lanceolaria); buildings and furniture - -	56	60-80
Nerreloo (Elæodendron); house-building - - - -	56	40
Otte, (Croton); house-building, ordinary *Paloo* (Mimusops hexandra.); oil-presses, bridges, &c.; ripe berries are eaten - - - -	36 68	10 10-70
Pamburoo (Limonia Missionis); buildings; the wood, when variegated, is beautiful, and prized for cabinet-work - - - -	48	40
Patta Del (Artocarpus, sp.); boats, buildings; fruit used for food. See *Abudel* and *Del* - - -	34	30
Patheale (Bridelia retusa); common buildings - - - -	42	40
Petan (Bauhinia tomentosa); boxes, walking-sticks, &c. - - -	57	—
Pehimbiye (Pteridophyllum decipiens); buildings - - -	68	50

	Weight per cubic foot. lbs.	Average durability. Years.
Penebarroo, (Eugenia Mooniana); rafters; the branches of this tree make the most durable of all fences	61	50-90
Pol, Cocoa-nut (Cocos nucifera); buildings, boxes, furniture. The fruit furnishes almost all the principal food used in a tropical country, milk, curry, oil, &c.:—the flower-stalk yields toddy, of which vinegar, arrack, and jaggery are manufactured; the husk gives coir for ropes and mats,—in short every part is useful -	70	20-50
Puwak, Areca-nut (Areca Catechu), furniture; the nuts are chewed with Betel leaves, tobacco, and chunam -	57	60
Ramenei Delle (Wendlandia bicuspidata); buildings and fences -	48	20
Rook attenne (Alstonia scholaris); coffins - - - -	26	
Samedera (Samedera Indica); buoys -	26	60
Sappoo (Michelia Champaca); carriages, palankeens, &c. - -	42	20-50
Sappoo Milile (Vitex trifoliata). *Vide ante.*		
Siyembela, Tamarind Tree (Tamarindus Indica); oil-presses, furniture, &c.; the fruit is well known -	80	80
Sooriya (Thespesia populnea); excellent for gun-stocks, hackeries, &c., and for blocks and buildings -	49	20-40
Sooriya Mara (Acacia, sp.); buildings and furniture - - -	42	20-30
Suvande (Kayea, sp.); buildings -	56	30
Tal, Palmyra, Reepers (Borassus flabelliformis); the native "ola books" are made of the leaves and toddy from the flowers, also jaggery which used medicinally W. Dea- hardening mortar -		80
Tarrene (Stylocoryne W		
boats, &c. -		
Teak of Ceylon (Tecton		
bridges and buildings		
Teak of Cochin (Tecton		
carts, bridges, and to n		

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products of New South Wales, animal, vegetable, and mineral remarkable and important in is. In the departments more our Class II, the collection in

New South Wales collection; highly important;

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Ceylon.

	Weight per cubic foot. lbs.	Average durability. Years.
casks, as the wood gives a fine colour and flavour to the liquor -	44	15-90
Teak of Moulmein (Tectona grandis); same purposes as the preceding -	42	15-90
Telemboo (Sterculia fœtida); buildings	26	30
Timberry (Diospyros Embryopteris); buildings; the juice of the fruit is rubbed on fishing-lines to harden and preserve them - - -	45	20
Ukbeiriye (Carallia sp.); buildings -	5	80
Velenge (Pterospermum suberifolium), poles of bullock-carts, and gun-stocks	36	—
Walboamboo (Symplocos laurinus); house-building - - -	36	15
Waldombe (Calophyllum Inophyllum). See *Dombe*		
Walukeene (Calophyllum, sp.); masts of boats - - - - -	39	10
Weawarene (Cratæva religiosa); buildings and pestles - - - -	62	60
Welipiyanna (Tetracrypta cinnamomoides, Gard. et Champ.); house-building - - - - -	35	40

As Mr. Layard's collection of woods has the native names only, and obviously contains many repetitions, I pass it wholly over.

Fibrous Substances.—Barks and Piths.

Fibrous substances: chiefly identical with those of India.

Nearly all the fibres in the Cingalese collection have already been enumerated and commented upon in the East Indian collection; and those that are not in this predicament are unaccompanied by any remark, except the two following:

Gnidia eriocephala, (a plant allied to the Mezereon) yields a strong, flexible, silky fibre adapted to the manufacture of paper; and its boiled bark makes an abundant jelly. Specimens of pulp and paper are exhibited, accompanying specimens of the inner bark.

Antaris saccidora, from the bark of which tree very strong and elastic sacks are made by the natives of Ouvah. The trees chosen for the purpose measure about a foot in diameter. The felled trunks are cut into lengths, and the bark is well beaten with a stone or club till the parenchymatous part comes off, leaving only the inner bark attached to the wood, which is

then easily drawn out by the hand. The bark thus obtained is fibrous and tough, resembling a woven fabric: it is sewn at one end into a sack, which is filled with sand, and dried in the sun.

Gums and Resins.

Gums, resins, and drugs; of small value.

Mr. Layard's collection of *Gums* amounts to 23, and almost all are accompanied with their generic and specific appellations; but the substances themselves are mostly of Indian origin, and the catalogue contains no remarks, except in reference to the *Gamboge* (Gambogia Gutta), viz., that it is not common and appears to be confined to the Badulla district, as is the *Gum Kino* (Pterocarpus Marsupium); and that other trees, of the same tribe, yield a gum which much resembles Gamboge in appearance.

Oils and Drugs.

Mr. Layard sends samples of 31 *Oils*, with native and scientific names, and brief notice of their uses, and Mr. T. A. Pieris 30 *Cingalese Medicinal Oils*, with native names and properties (real or imaginary), and 12 samples of *Essential oils*, together with *Medicines* used in native practice, with their names (Cingalese and botanical), and a brief notice of their uses.

Among *Miscellaneous* articles we may notice some remarkable specimens of *Rattans* (slender climbing palms), especially 2 of *Calamus verus* from Mr. Layard, one measuring 270 feet, the other 230 feet in length (these have been presented to the Museum of Kew); beautiful *furniture, carved boxes*, &c., of native woods, such as *Calamander, Ebony, Tamarind*, &c., and various fruits modelled in wax; *Cocoa-nuts* and their products; agricultural implements of various kinds, &c. &c.

In this Class a Silver Medal was awarded to the Ceylon Executive Committee, and a Bronze Medal to Mr. Layard.

VI.—NEW SOUTH WALES.

(Special Commissioners: Edw. Deas Thomson; W. (now Sir William) Macarthur; and M. H. Mousle, Esqs. Secretary of the Committee, Mr. F Bousfield. Agents, Messrs. Desgrand and Son.

New South Wales collection: highly important;

The natural and industrial products of New South Wales, if we take into view the animal, vegetable, and mineral kingdom, are among the most remarkable and important in the Great Exhibition at Paris. In the departments more immediately connected with our Class II, the collection in

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its importance chiefly due to Sir W. Macarthur's exertions;

question is peculiarly interesting, and especially for native woods. It reflects great credit on the several gentlemen who acted as Commissioners in forming it, as well as on the Colony itself, for the liberal way in which they met the heavy expenses which it involved The Legislature of the Colony, at the recommendation, of the Governor-General, appropriated out of the Colonial Revenue 6,000*l.*, besides a sum of 5,000*l.* lent for the purchase of gold; the Commissioners undertaking that all specimens should be sold in Paris or London at the close of the Exhibition, and the proceeds be paid to the colonial agent to the credit of the colony.

Wm. Macarthur, Esq., (since Sir Wm. Macarthur), was mainly entrusted with the Commission department in Paris: a more fortunate choice could not have been made. He was himself assiduous in forming the noble collection of woods; he is familiar with the aspect and qualities of the respective trees; and his botanical knowledge has enabled him to attach the scientific as well as popular names to many of the specimens. The samples are generally about four feet long, by one foot or more wide, smoothed on one side and part of the smooth surface polished; thus exhibiting both the outside and inside in the natural and the worked state. Sir William Macarthur also brought well-dried specimens illustrative of the trees which yield these woods, bearing corresponding numbers: and he presented one set to the *Jardin des Plantes*, another to the British Museum, and another to the Museum of the Royal Gardens, Kew; thus being enabled, when in Paris, to solve some doubtful points, by reference to the opinions of M. Decaisne and Mr. Robt. Brown. Perhaps there has never been transmitted from any colony at any one time so large a collection of woods new to commerce, and promising to prove useful for timber and for various economical purposes, particularly for carpentering, cabinet-work, and inlaying, accompanied, too, with notes upon the uses, and all, or nearly all, scientifically named. Hitherto, most of them have only been used for firewood in the colony. Now that the attention of merchants, artizans, and men of science has been called to them, there is every reason to believe that the merits of many will be duly appreciated, and that their export to Europe will augment the resources of a colony situated almost at our antipodes.

The printed names and the rather copiously written remarks attached to each specimen, together with an excellent private catalogue which was freely laid before the jury, and the further assistance of Sir William Macarthur's personal attendance and remarks, have greatly facilitated my investi-

gation of this collection. That portion which Sir Wm. M. was chiefly instrumental in forming, comes from the Southern district of New South Wales, and mainly from the environs of Sydney and from the Illawarra. The vegetation of the latter country is very peculiar, approaching a tropical character. Though only six months were allowed for collecting these woods, they amount to 300 species, including many of botanical and economical interest. Of the latter, "22 are excellent hard woods, of very great durability; 12 are suitable for turning or other manufacturing purposes; while 16 are highly beautiful and adapted to cabinet and ornamental work. One specimen affords a fine yellow colour for dyeing. Sir Wm. Macarthur's intimate acquaintance with these woods and with their localities justifies him in considering them to belong to three different kinds of woodland country, which he divides into classes A, B, and C, and he prefixes one of these letters to the name of the tree, so as to designate the nature of the district where it is found.

Forest-country of three kinds;

Class A. – *Trees confined to more or less open forests* with little or no underwood: their trunks are more or less naked, great height being a more conspicuous feature with them than diameter; branches thinly clothed with persistent, dry, dull-coloured, thick, leathery leaves, abounding in essential oils, and, in their decomposition, adding but little vegetable matter to the soil. The largest of these trees inhabit rather poor soils, and they are frequently unsound at heart.

Class B.—*Barren Scrub,* either wholly covered with low, shrubby vegetation, without trees, or with stunted trees, seldom or never producing serviceable timber. The same dry vegetation prevails as under the last Class: and the bush-fires, which sweep over these barren scrubs every four or five years at least, prevent the majority of the species from attaining large dimensions. Here most of the beautiful flowering shrubs of the colony grow; and the soil is always rocky, stony, or sandy.

Class C.—*Rich Brush, or Cedar Brush,* rarely of great continuous extent, but often alternating at short intervals with Class A, and existing only at moderate distances from the sea, or, at all events, eastward of the great dividing range. Here a rich soil often results from the disintegration of the peculiar rocks; and it usually follows the course of streams. The cedar brushes are found in the greatest perfection at Illawarra: the trees are very lofty, slender, and clothed with beautiful, thick, bright green foliage, and often graced with noble climbers (bush-ropes), which attain the topmost branches, and frequently throw themselves from

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tree to tree. Shrubs are few in these brushes. Four tree-ferns and two palms grow at Illawarra.

the forest-country described, &c.;

The summer heats are less scorching and the temperature is more equable in the cedar brushes than in less wooded parts; and the bush-fires rarely, if ever, reach their tangled recesses, which present great difficulties to the investigator. For the sake of the *Cedar* (Cedrela Australis, a tree very nearly allied to the celebrated *Toona*, Cedrela Toona of Eastern India), and hitherto for that alone, the sawyers have explored almost every nook of the forest whence the tree in question could, if felled and cut, be got out. It is remarkable how few of the trees in this region are seen in flower and fruit, which makes it extremely difficult to determine their names, and they grow so closely packed and intermingled that a half-mile track will sometimes show upwards of 60 kinds. Very grotesque are their forms;* the trunks are rarely cylindrical but picturesquely irregular, and loaded aloft with huge masses of mosses, ferns, and orchids, the latter exhaling a delicious fragrance. The timber of this Class, of which almost every brush possesses some peculiar kinds, differs remarkably in its fine grain and general beauty from that of Class A. It is generally sound at heart, but not to be compared for durability, especially if exposed to damp, to the coarse and almost imperishable woods of Class A.

Sir Wm. Macarthur begs that it may be remembered that the short time in which these woods were collected precluded the possibility of seasoning them well: also, that many kinds had not arrived.

Most remarkable trees noticed.

Among the 245 woods of the Southern districts, I can only notice some of the more remarkable, which promise to be useful as timber,† or which are curious in their structure and therefore interesting to the botanist. Following Sir Wm. Macarthur's catalogue, the first mark indicates the class to which each tree belongs; 2, its botanical name; 3, its name

* Among the most striking are the *Giant Nettles* (Urtica Gigas), trees of noble proportions, often forty feet round at four feet from the ground, and 150 feet high. Their trunks rise in a series of buttresses, and attain 120 feet before giving off a single branch. The *Giant Figs*, of which there are five kinds in the Brushes (Ficus macrophylla, and other species), are still more huge, the girth having been found to measure eighty-six feet. It is almost impossible to convey by description any idea of the wild and grand character of these singular trees, whose stems resemble fluted columns, supported by enormous buttresses, extending to a great circumference at the base, and by roots which rise above ground in ridges like walls, among which a hundred persons might be easily concealed.

† This collection afforded samples for the valuable "Series of Experiments on the Strength and Resistance of Various Woods;" the results of which are given in the first part of the Report on the Paris Universal Exhibition, presented to both Houses of Parliament by command of Her Majesty. 1856, p. 411.

among the aborigines (often of great importance to the colonists, by reason of the tact with which these natives distinguish and name their trees); 4, the local name (of the colonists); 5, the diameter; and 6, the height. With great propriety Sir Wm. Macarthur gives first the scientific name.

C. *Polyosma Cunninghami* (Yerralla). A small tree, likely to be useful for cabinet-work.

C. *Brachychiton acerifolium* (Couramyn—Flame Tree of the colonists). Wood prettily veined, but soft; fibrous bark used by the natives for nets and fishing-lines. Flowers red and beautiful.

C. *Eupomatia laurina* (Balwarra). Wood yellowish-brown and prettily veined, but soft.

C. *Stenocarpus salignus* (Meleyn—Beef-wood and Silky Oak of the colonists). A beautiful wood, which takes a high polish, and is adapted for veneering and cabinet-work.

C. *Cryptocarya* (Oorawang—Laurel). A noble tree, 70–120 ft. high, wood of no great value.

C. *Trochocarpa laurina* (Beranduna—Beech). A pretty, small tree, with close-grained ornamental wood.

C. *Piper, sp.* (Mao-Warang—Pepper-vine). A magnificent woody climber, 150–180 ft. long. Interesting to a botanist but the wood is worthless.

C. *Doryphora Sassafras* (Calang—Sassafras, or Saxafrax) A beautiful tree, with highly fragrant foliage, and a bark which contains a tonic bitter; the wood is soft and weak.

C. *Acmena, sp.* (Galang-arra—Brush-cherry). Wood close-grained and hard; fruit handsome and sub-acid.

C. *Cargillia Australis* (Booreerra—Black-plum). Wood fit for turnery.

C. *Icacineæ, sp.* (Ngneureen nanan—White Maple). Magnificent tree, 100–150 ft. high; bole of a triangular form, wood close-grained, tough, adapted to joiner's work and turning; it has a bitter principle.

C. *Pittosporum undulatum* (Wallandun-dyrren). Wood hard and white, suited for veneers and turnery; it may perhaps prove a substitute for Box in wood engraving.

C. *Elæodendron Australe* (Courai-uo). Slender tree; its wood close-grained, fit for turnery and cabinet-work.

C. *Aphanopetalum sp.* (Tdjeunen—White Myrtle and Blue Ash). A noble tree, 80 to 120 feet high, with close-grained, easily worked, and probably valuable wood.

C. *Podocarpus spinulosus* (Dyrren-dyrren—Pine, White Pine). A beautiful straight-growing tree, 70 to 120 feet high; wood close, easily worked, sometimes very handsome;

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it would probably be adapted for making the sounding-boards of musical instruments.

C. *Ceratopetalum apetalum* (Boola—Light-wood, Leather-jacket, Coach-wood). A beautiful tree, 3–4 feet in diameter, 80–130 feet high; its wood is soft and fine-grained, agreeably fragrant, and much in request for coach-building, but not durable when exposed to damp.

C. *Tristania neriifolia* (Ooramilly—Water Gum). 100–130 feet high; wood close-grained and elastic, prized for boats.

C. *Sapindaceæ, sp.?* (Dawawah—Maiden's Blush). A beautiful, umbrageous, small tree, named from the pink hue of its fine-grained soft wood; the largest specimen was 14 feet in circumference.

C. *Epicarpurus* (Marrulang—Rough Fig). A small elegant tree, with milky sap, and hard-grained firm wood, likely to serve for turnery, &c.

C. *Achras Australis* (Jerrawawa — Brush Apple, Wild Plum). The thick milky sap tastes like fresh cream; the wood is close-grained and prettily marked; the abundant large purple fruit is coarse and flavorless.

C. *Pomaderris, sp.* (Murr-rung—Red Ash, Coopers' wood). Wood excellent, close-grained, good for turnery, &c.

C. *Cupania Australis* (Burrenedura—Tamarind Tree). Resembling the tree whence it derives its name among the colonists in its magnificent pinnated foliage and large racemes of acid fruit,—used for preserves. The wood is white, close-grained, and firm.

C. *Acmena, sp.* (Kangaloon—Myrtle, White Myrtle). Wood extremely hard and heavy, prized by the Aborigines for their clubs, boomerangs, and spear-points; it requires careful seasoning.

C. *Acacia sp.* (Marrai-uo—Sallow). Wood prized for axe-helves, combining strength and toughness, beautiful in grain and color, and likely to be valued for cabinet-work, &c.

C. *Hibiscus heterophyllus* (Dtharang-gang—Coryjong). A small tree, with beautiful flowers, soft and spongy wood, and bark which the natives use for fishing-lines and nets.

C. *Exocarpus cupressiformis* (Ko-ieyatt—Cherry). Wood close grained and good for turnery, but liable to split.

C. *Aster* (Eurybia) *argophyllus* (Musk Aster). A low, branching tree, said to form exclusively the vast dense thickets between Gipps Land and Western Port. The leaves and young shoots smell like musk; the heart-wood is dark and handsome. This tree, 15-30 feet high, is the well-known Australian Musk-plant of our greenhouses, where it appears as a small shrub.

C. *Myrtus trinervis* (Dthalandoon). This, again, is but a

very small shrub under cultivation in Europe, while it attains in New South Wales a diameter of 2 feet and a height of 70. The wood is hard and close-grained, but the larger trees are rarely sound.

C. *Callistemon salignum* (Boodjoong—Broad-leaved Tea-Tree). Wood hard and close-grained, but like the other species of Callistemon and Melaleuca, apt to split in drying, compensated by being nearly imperishable under ground.

C. and A. *Melaleuca styphelioides* (Naambarr—Prickly-leaved Tea-tree). Wood like the last. The outer bark of these two trees, as in other species of the genus, peels off in innumerable thin soft membranous layers or plates, which have been recommended as useful in paper-making. Sir Wm. Macarthur possesses a natural specimen (layer) which has been successfully printed upon. In color and texture it resembles a very delicate slice of cork, being soft and velvety. Beautiful layers of the bark of Melaleuca uncinata are also in the collection.

C. *Mertensia, sp.* (Ba-ou-oon—Cockspur Thorn). A large thorny shrub, with dark yellow heart-wood, used to dye yellows and browns.

C. and A. *Corypha Australis* (Dtharowal—Cabbage Palm). A very lofty palm, 120 feet high, and abounding along the sea-coast from 38° S. to the Tropics. Its unexpanded fronds, after being immersed in boiling water and dried, serve to make hats, of which a specimen is in the collection.

C. *Urtica Gigas* (Goo-mao-ma—Nettle-tree). Already mentioned in foot-note, p. 65. The leaves are often 12 to 15 inches across; their sting is very formidable. The wood is too soft and spongy to be of any value for timber; when dry it is used as a slow-match.

C. *Duboisia myoporoides* (Ngmoo—Corkwood). A small tree, with corky bark, and white, close, soft, but firm wood, which is excellent for wood-carving, and pretty for inlaying, &c.

A. *Eucalyptus, 2 sp.* (Iron-Bark). First-rate, durable timber. A specimen is exhibited which was cut more than 55 years ago. These trees are also called Gum-Trees by the colonists and have many other local names, but it has been found impossible to determine accurately their scientific appellations. Most of them are of considerable thickness, and from 50 to 200 feet high; and their wood is remarkably hard and durable, useful for ship-building, wheelwright's work, &c.

A. *Angophora, sp.* (Apple Tree). The wood, when free from gum veins, is excellent for wheels, &c.

A. *Syncarpia, sp.* (Boorcea—Turpentine Tree). The huge trunks of this myrtaceous tree are 35 feet round and 200 feet

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high; the timber is durable under ground, but apt to split when exposed to the air.

A. *Melaleuca*, 3 *sp.* (Tea-Trees.—The timber is of the same quality as the preceding (*Syncarpia*).

C. *Ficus, sp.* The largest tree of the Cedar brushes, but with indifferent wood.

A. *Persoonia linearis* (Naamburra—Jibong). Tree small, with close and prettily marked woods.

A. *Brachychiton populneoides.* (Courymyn.) A small tree, of which the roots contain much mucilage, and are eaten by the aborigines, who use the bark for nets, &c.

A. *Acacia falcata* (Wee-tjellan—Lignum Vitæ). Wood close and ornamental; the bark contains much tannin and is used by the natives to poison fish.

A. *Angophora, sp.* (Boonda—Apple Tree of Camden). A beautiful tree, its wood, when free from gum veins, is valuable for wheelwright's work and for boards.

A. *Tristania laurina ?* (Water-Gum of the Nepean river). A remarkably small tree, of which the wood is peculiarly hard and bony, and valuable; it requires careful seasoning.

C. *Tristania, sp.* (Water-Gum). Wood prized for its toughness and strength, and used for the knees and ribs of boats, &c.

A. *Casuarina suberosa* (Dahl-wah—Forest Oak, Beech, and Shingle Oak). Small, and chiefly used for shingles, but probably valuable for cabinet-work, being handsome.

A. *Eucalyptus*, 3 *sp.* (Woolly Gum-Tree, Swamp Mahogany, and Rough-leaved Iron-Bark). Trees of but moderate value as timber, but of such quick growth, that one tree which, when planted in 1829, was not thicker than a quill, had attained to 70 feet long when felled in 1854.

A. *Acacia, sp.* (*Myall* of the colonists). A graceful tree, one of several species called *Myall;* all have rich dark-coloured wood which smells like violets.

Monotoca albens (Beech). A large shrub of many stems, the wood is used by carpenters for handles to their tools.

B. *Xylomelum pyriforme* (Merridgee-couroo—Wooden Pear). A small tree, yielding a dark, prettily marked, but coarse-grained wood, which affords handsome veneers.

C. *Cedrela Australis* (Polai—Cedar). Tree from 80 to 120 feet, sometimes 10 feet in diameter. The most valuable wood in the colony, and exclusively used by the colonists for joinery and cabinet-work; for fifty years it has been extensively exported.

C. *Vitex ? sp.* (Beech, White Beech). A noble tree, 140 feet high, its wood much prized for the decks of coasting ships, of bright silvery grain, and said to have the rare merit

of not shrinking and splitting, as the timbers of this colony generally do.

C. *Alsophila*, 2 *sp.* From the curious stems of these tree-ferns very pretty vases are carved.

C. *Livistona inermis?* (Dwarf Palm.) 6–10 feet high. From the slender stems walking-canes are made. The name is probably incorrect. It is a very small pinnated-leaved Palm and has been received living in the Jardin des Plantes.

C. *Endiandra glauca* (Teak-Wood of the colonists). A magnificent tree, 100–140 feet high; its wood is hard, close, and fine, dark-coloured in the duramen, with a powerful aromatic fragrance. A very strong and valuable timber.

B. *Acacia decurrens* (Black Wattle). 40–60 feet high. Bark valuable for tanning.

C. *Meliaceæ*, *sp.* (Rosewood). 3–6 feet in diameter and 80–120 high. The timber of this beautiful tree is highly valued; it is ornamental; and its essential oil, of agreeable fragrance, recommends the use of the wood for bedsteads, as insects will not lodge in it.

B. *Eucalyptus sp.* (Mahogany of the colonists). Noble timber, 130 feet high, very strong, and so durable that one of the specimens, taken from a principal and much exposed rafter of Parramatta church, built in 1778, is still perfectly sound.

Avicennia tomentosa (Mangrove). A low branching tree which inhabits the salt-water estuaries; its wood, when small, is valued for stone-masons' mallets, because of its closely-interwoven fibre.

Trees of Moreton Bay and Wide Bay; sent by Mr. Moore, of the Sydney Botanic Garden.

The collection of Indigenous Woods, from the *Northern Districts* (Moreton and Wide Bays), was formed by Mr. Charles Moore of the Sydney Botanic Garden, under circumstances of peculiar difficulty, chiefly arising from the want of manual assistance. He therefore confined his attention chiefly to the trees which were likely to be of commercial and economical value. The number of specimens, as already stated, is about ninety. Their names appear to have been given in Europe from examination of corresponding flowering branches, which were communicated, we believe, to Mr. Moore, of the Chelsea Botanic Garden, and subjected to some correction at the Jardin des Plantes. The printed catalogue (yet unpublished, and hitherto not circulated among jurors,) gives the name in English of the tribe to which the tree belongs, its local name (if it has any, but this is of rare occurrence,) among the settlers, the average height and diameter of the trunk, together with remarks made on the spot where the tree was felled, and such information as could be obtained about the timber. The list (of ninety) includes about a dozen

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kinds which appear likely to be useful for cabinet-work and furniture and general purposes. Among the most beautiful are the *Moreton Bay Cypress*, the *Oxleya* of the same district, the "*Yellow-wood*" producing a yellow dye from the heart-wood and a brilliant red from the bark (is it not rather a Maclura or some Moraceous plant?), the "Pine Tree," and others. A kind of *Dogbane* is in the collection, of which Mr. Moore says that the bark is more intensely bitter than Cinchona and partakes of the same nature. (N.B.—M. Brongniart and M. Milne Edwards have undertaken to analyse it.) There is also a specimen, though small, of the extraordinary Bottle tree (*Delabechea rupestris* of Lindley), of which the height is often 30 feet, and the width 16; and the centre is almost wholly an eatable pulp. (N.B.—A section of a moderately sized specimen is in the Exhibition, and in this collection; but a larger one, said to be 20 feet long and 12 wide, is too large to be deposited here.) There are fine specimens of the *Moreton Bay Pine* (Araucaria Cunninghami), considered the most valuable timber of that district, and obtainable in unlimited quantity. The tree, in favourable situations, grows between 200 and 300 feet high, with a perfectly solid shaft-like stem. *Grevillea mimosoides* of Wide Bay is allied to the Silky Oak of Moreton Bay, and its timber is employed for furniture. The "*Kauri Tree*" of Wide Bay is probably hitherto unknown to naturalists. It is doubtless a Dammara, and produces timber equally large and serviceable as the "Kauri" (Dammara Australis). Its place of growth is limited between Moreton Bay and the Burnett River; its stems are 4–5 feet in diameter, and attain a height of 150 feet. I do not find the magnificent *Bunya-Bunya* (Araucaria Bidwilli) in this collection of Woods; though the Bunya shrub is mentioned in the catalogue, and though its noble fruits and foliage are in another part of the Exhibition (they have been since presented to the Museum at Kew). The Moreton Bay Chestnut (*Castanospermum*) yields a wood which is very useful for cask-staves.

The miscellaneous collection of woods contains, among many other articles, fine specimens of the *Grass Gum-trees*, of *Kingia;* of *Myall wood* (Acacia sp.), already noticed as exhaling a smell like violets, both rough and polished; stem of the "*Dogbane bark*," suspected to be a Tabernæmontana, to which it is certainly allied (evidently not a Rubiaceous plant); wood of *Erythrina Vespertilio;* and the *Cork-wood* of Moreton Bay.

One of the most interesting of the objects (placed in another part of the Exposition) is the last remaining portion

of *the Tree*, near which was buried (the ships then lying in Botany Bay) the body of M. Le Receveur, one of the Naturalists attached to La Peyrouse's expedition. His name and portions of a few words carved on the bark, some feet above the ground, are still discernable. This fragment is now, with great propriety, presented to the French Government. It is to be regretted that the tree has been much injured by the Bush fires of the Natives.

Furniture, &c.

Since my official examination of this fine collection of woods from New South Wales, there have been deposited on the landing-place of one of the staircases in the Palais de l'Industrie, five cabinets or book-cases and four tables made from a great variety of the above-mentioned woods, accompanied by lists of their names. I may safely say that few objects in the Exhibition are so worthy of atttention; and their value will be determined by more competent judges of another class. The other objects that belong to my series of vegetable products are miscellaneous and not extensive, and more information is to be desired respecting them.

From the period of its earliest discovery, New South Wales has been described as a country singularly barren in native eatables; and the climate would appear equally unfavourable to the production of any great variety of native Gums, Resins, Fibres, Drugs, Dye-stuffs, &c. Further discoveries may, however, correct or modify this statement. The following objects deserve notice :—

Miscellaneous Articles.

Dye-wood from *Oxleya xanthoxyla;* wood and bark and dye; also wool and cotton dyed with it, and specimens showing the interior or dyeing portion of the wood. The color is a rather rich yellow brown. The first Prize Gold Medal in New South Wales was adjudged for it. Also extracts of the wood. Mr. Oee.

A beautiful *Hat*, like the Panama hat; sample of articles made by prisoners in Cockatoo Island, from the leaves of the *Cabbage Palm* (Corypha Australis). "One-third of the proceeds goes to the prisoners as a fund when they become free; the remainder they have for tea, sugar, &c. The leaf is dried in the air (not in the sun), then scalded and split into widths (very narrow) and plaited. Twenty-four rounds of plat are required to make one inch, twenty-six stitches to each inch, and 240,552 stitches in each hat. One hat takes 257 yards of platting. The tree grows at Illawarra."

In this class a Médaille d'Honneur was awarded to Sir Wm. Macarthur; a Silver Medal to Mr. Chas. Moore; and a Bronze Medal to Mr. Bousfield (Secretary to the Commismissioners for New South Wales), as co-operator.

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VII.—VICTORIA (AUSTRALIA).

Edward Bell, Esq., Commissioner; Mr. N. Domis, Agent.

Victoria.

Victoria collection: of trifling value; it might have been much greater if Dr. Mueller had been employed.

This (as concerns our class) is of small value, which is the more to be regretted as Dr. Mueller, the Government Botanist, has distinguished himself by his varied information, extensive travels, and accurate researches into the interior of the Victoria Colony. To him the collection owes 24 *Native Woods*, correctly and botanically named (bearing also their colonial appellations): six are communicated by Mr. Foot, and eight by Mr. Gibbons. They are, generally speaking, good specimens; and many of them, if they had been accompanied by a note of their qualities, would doubtless have attracted attention, and been found of commercial or artistic value,—the fragrant *Myall wood*, for example.

Dr. Mueller also sends of *Barks*, probably useful for tanning, as follows:

Sassafras Bark (Atherosperma moschata), *Santalum persicarium* (a food of the aborigines), *Wattle Bark* (Acacia mollissima and dealbata) and *Iron Bark*.

There are three *Gum Resins*, viz., Gum of the Australian Boxtree, Resin of Red Gum, (and Resin of Kauri Pines from New Zealand.)

Three books are filled with a well-preserved general collection of Australian Plants: two consist of dried specimens of indigenous plants, "illustrating their usefulness;" (as how?) one is a fascicle of indigenous grasses.

Mr. Murray sends a specimen of *Murray Pine* (Callitris Preissii), which yields *Gum Sandarach*; *Volatile Oil*, distilled from the foliage of the *Red Gum-tree* (Eucalyptus rostrata), similar to Cajeput oil. A species of *Polyporus* (without name) seems identical with the well-known European styptic, the *Medicinal Agaric* (Polyporus Laricis.)—A large piece of bark bears, on its inside, some curious drawings by the natives of Victoria.

The above are all the vegetable products that merit notice. A printed Catalogue was given to the Jury, but it is void of any useful information.

In this Class a Silver Medal was awarded to the Colony; and a Bronze Medal to Mr. A. Clarke.

V. Diemen's Land.

VIII.—VAN DIEMEN'S LAND.

(Special Commissioner: Mr. R. W. Nutt. Agents: Messrs. Desgrand and Son.

V. Diemen's Land collection: less valuable than might be expected;

The fine collection of Vegetable products, which Van Diemen's Land contributed to the British Exhibition of 1851, had led me to expect a far completer choice of speci-

mens than are displayed on the present occasion. They occupy but little space; and save some furniture, made from native woods, there is hardly anything which requires examination by the Jury of the Second Class. Even as regards the collection of woods, which is considerable, and includes blocks and planks of various sizes showing the transverse and horizontal section, both polished and unpolished, the close of the Exhibition arrived, and several months longer elapsed, ere a catalogue appeared. The names affixed to a portion only of these samples were not merely defective, but often evidently incorrect; and I had been compelled to pen some unfavorable remarks on the subject of the disappointing nature of the collection, when I received a list of the Tasmanian contributions, from which I make the following extracts. The remarks upon the woods are by Joseph Milligan, Esq.; and I gladly testify to their importance and general value.

specimens few and ill-named.

Bursaria spinosa (Tasmanian Boxwood) is a small tree, about 25 feet high and half a foot in diameter; but its wood is valuable for its hardness and even grain, and the profusion of its white and fragrant flowers causes it to be prized as an ornamental shrub.

Bedfordia salicina (Dogwood). Though only attaining the height of a shrub, the root-part swells so much as to yield boards three feet long and a foot and half across, which are of beautiful quality, taking an extremely high polish and showing veins, mottlings, and streaks of a nearly black color on a light ground. Ornamental boxes are exhibited of this wood.

Dacrydium Franklinii (Huon Pine). The most elegant of Tasmanian woods, beautifully marked, and with a satiny lustre on its paler parts. Logs of it are often found half buried in the soft cold sand, which the tree affects, covered with moss and even with roots of other trees, and yet perfectly sound, and as useful to the sawyer and joiner as if only felled that day. Such durability of timber is unequalled. The tree is about 100 feet high, and except that it ramifies too much to make good spars, it is esteemed above all others for ship-building, house-building, furniture and cabinet-work, machinery, turnery, &c. The trunk has often large protuberances, which are very handsome when cut and polished. Tables of Huon Pine are in the Exhibition, and fine planks; also a bookcase ornamented with brackets, gilded with Tasmanian gold, (now in the Museum of the Royal Gardens of Kew).

Huon Pine.

Eucalyptus Globulus (Blue Gum-tree). The most valuable of Tasmanian timber, attaining a height of 250 to 350 feet, and a circumference of 50 to 100 feet, at four feet from the

Gum-trees.

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ground. Frequently the stem attains 200 feet high before giving off a single branch. The strength and elasticity of the wood are unequalled: it is in constant request with ship-builders, carpenters, millwrights, and engineers; bridges of great extent are wholly constructed of it, one, for instance, near Hobart Town, which is nearly 100 feet long, with a roadway of 24 feet. Like most of the Eucalypti, it yields a red astringent medicinal gum, used as Kino, and an essential oil like Cajeput is obtained by distilling the leaves. A section is exhibited which was taken from a *Blue Gum-tree* 320 feet high, which sold, (in palings, shingles, &c.,) for the sum of 245*l.*, in 1854, and would have fetched twice as much money the previous year, when the demand for wood was far greater. From D'Entrecasteaux Channel and the South side of Van Diemen's Land the Blue Gum-tree had been exported in various shapes, to the amount of 800,000*l.* in three years.

Casuarina quadrivalvis (She Oak) and *C. stricta* (He Oak) both afford a timber called *Beef-wood*; it is very hard, beautifully spotted, streaked and marked, and susceptible of a perfectly mirror-like polish; the colour is handsome. It is much esteemed for picture-frames, chairs, and small articles of cabinet-work.

Stringy barks.

Eucalyptus gigantea (Stringy bark). One of the largest of Tasmanian forest trees, yielding only in dimensions to the previous species (E. Globulus): the average height is 210 feet, and the circumference, at four feet from the ground, about 50 feet. The timber is in great demand for house building and all common purposes, where solidity and strength are the chief requisites. The natives make catamarans of the bark of the Eucalypti, and a model, made by one of these people, is in the Exhibition.

There are several species of Gum-tree in Tasmania; one is called *Peppermint tree*, and is distinguished by its fibrous-barked trunk and smooth clean branches.

Fagus Cunninghami (Tasmanian Myrtle). This tree is in reality an evergreen Beech, inhabiting all the parts (except the Eastern) of Van Diemen's Land, growing in immense forests, and rivalling the Giant Gum-trees in stature, while it excels them in the beauty of its wood. The cabinet-maker can procure it in slabs of the largest size: the grain is fine and the colour bright pink and red, variously waved and mottled with rich darker tints. It has been sent to England for carriage panels. Picture frames and chairs are made of it. There is a magnificent figured plank of this wood, dressed and polished, and three round tables.

Wattles.

Acacia dealbata (Silver Wattle). A tree which abounds in Tasmania, from the level of the sea to nearly 2,000 feet,

growing vigorously in great extremes of temperature, even where the mercury indicates 21° at sunrise. It is evergreen, and would probably succeed well in the South of England: it grows from 80 to 120 feet high, and measures from five to nine feet in circumference, at four feet from the ground. The bark is useful for tanning, and a large quantity of gum, like Gum Arabic, exudes during summer. The timber is useful only for coopers.

Acacia melanoxylon (Blackwood). An abundant timber tree, about 150 feet high; its wood is adapted to cabinet work, being richly grained, feathery, and hard: the plain parts are used for boat-building and wheels, and the bark for tanning.

Acacia mollissima (Black Wattle). The wood seems of no great value; but the gum which exudes from this species, and in less abundance from other Acacias, is pure, insipid, and highly nutritious. The aborigines of Tasmania used to eat it both fresh and slightly roasted, and even the children of the European settlers are very fond of it.

Acacia Sophora (Booby-alla). A straggling, much-branched, low shrub, of which the long pods were eaten by the natives of Tasmania. Wood used for turnery, and, when split, for hats and baskets.

Acacia sp.? (Rosewood of Tasmania). A beautiful cabinet wood, but neither sufficiently large or abundant to be of much importance: it resembles Blackwood.

Atherosperma moschata (Sassafras). A plain wood adapted for flooring, and extensively known as a superior material for carpenters' screws and printers' mallets, because it is of so soft and even grain. The dried leaves are used for a dye, and being full of a highly volatile essential oil they are medicinal: the bark, in infusion, is a stomachic and tonic.

Eurybia argophylla (Muskwood). Name derived from the strong odour diffused by the foliage. Though not of large stature, its wood is prized, especially the part procured from an annular enlargement of the trunk near the root, where the veins are remarkably graceful and varied, and the tints soft and harmonious. It is among the most valuable of cabinet woods.

Banksia Australis (Honeysuckle of Van Diemen's Land). A shrub 12–15 feet high, but valuable for the shade in summer and sheltering covert in winter, which its leafy top affords. The wood is only used for fancy work: the bark is employed and even exported for tanning.

Phyllocladus asplenifolia (Celery-topped Pine). Elevation from 120–150 feet, average girth six feet. The timber is tough and fine-grained, good for flooring, window-frames,

and farm implements, while the young saplings make unrivalled whip-sticks. The wood contains a fine white but not abundant resin.

Croton, sp. (Pinkwood). A shrub, of which the wood seldom exceeds six inches in diameter, but is of a lively pink color and takes a good polish.

Callitris Australis (Oyster Bay Pine). A handsome pyramidal tree, about 120 feet high. An allied species (C. Gunnii) is a particularly handsome shrub. They yield a fine white resin.

Notelæa ligustrina (Iron-wood, of Tasmania). The wood of this small tree is as hard as ebony, and used for turnery and inlaid work.

Olea apetala (Iron-wood of Norfolk Island). No timber tree of Norfolk Island is so important; its wood is extremely hard and durable, well veined, and of a fine close grain. A pair of candlesticks, turned of this wood, are in the Exhibition.

Exocarpus cupressiformis (Native Cherry). Gun-stocks and inlaying are made of the wood.

Anopterus glandulosa (Tasmanian Laurel). Rather a shrub than a tree, though its beautiful wood serves for ornamental cabinet-work; the bark is used for tanning.

Zieria arborea (Stink-wood). Woodsmen and colonists have given the shrub this name, on account of the strong ammoniacal odour, which recommends it to the aborigines, who bind fillets of twigs and leaves round their heads and necks to cure headache and other ailments. The tall straight young saplings, 15 feet long, are prized for spears.

Alyxia buxifolia (Scent-wood of Tasmania). A straggling shrub; the wood, only a few inches in diameter, diffuses a rich and enduring smell, resembling that of the Tonka bean.

Pittosporum bicolor (White-wood). Wood used by cabinet-makers; also by the aborigines for hunting-spears, with which they used to pick off game faster than a sportsman could shoot them. For war javelins, the heavier wood of Leptospermum or Casuarina was preferred. The wood is so close-grained and white, that it might serve the engraver's purpose.

Lagunea sp. (White-Oak). The largest of the Malvaceæ, attaining in Norfolk Island a height of 80 feet, and a circumference of 15 to 18 feet. The wood is of little value.

Cibotium Billardieri (Tree. Fern tree). It attains a height of 20 or 30 feet, and sometimes even of 40, when drawn up by growing in close ravines. The trunk is from a foot to 18 inches across, with a core which used to be eaten by the natives, though it is astringent and by no means nourishing.

Specimens of the pith, somewhat resembling a raw turnep in consistency and appearance, are in the Exhibition.

Melaleuca squarrosa. The natives make boats of the bark, and navigate them very skilfully.

Araucaria excelsa (Norfolk Island Pine). The most elegant of the Coniferæ. The knots of it are beautiful for turnery, and cups made from them are in the Exhibition. A resin is afforded by it.

Xanthorrhœa Australis (Grass-tree of Flinders' Island). A red gum or balsam exudes from every part of the plant, which yields a rich perfume when burnt, and used to be employed as rouge by the aborigines. It might form a valuable ingredient for incense and sealing wax. Specimens of the gum are exhibited.

Furniture made from V. Diemen's Land trees.

Beautiful articles of Furniture made of the Tasmanian Woods are in the Exhibition. I would specify a table of *Blackwood* (Acacia melanoxylon); another of the *Huon Pine* (Dacrydium Franklinii); and still more striking is a bookcase made of the latter, with which few articles in the Exhibition could have vied, if the ornamental part and the general workmanship had been on a par with the material. There is also a table of *Muskwood* (Eurybia argophylla), (*see* p. 98,) of considerable beauty, and some very well carved brackets, four in number, representing Flowers, Fruit, Birds, and Fish, in different kinds of wood.

Barks and esculent substances.

The collection of Barks for Tanning is very small, chiefly Wattle bark (Acacia mollissima), Sassafras Bark (Atherosperma moschata), and Cherry Tree bark (Exocarpus cupressiformis). Gums are still fewer; the Kino of the *Blue Gum* is already mentioned.

Among Miscellaneous Articles are *Native Bread*, which is a subterranean Fungus (Mylitta Australis), perhaps parasitical on the roots of trees, close to which it grows. The aborigines are fond of this article of food, which looks far from inviting to Europeans; it has a peculiar faint smell, and a not unpleasant flavour. In the proportion of one part to three of rice or sago it makes a good pudding, and is said to improve soup. Among the Fungi are the *Caterpillar Plants* (Sphæria Gunnii), which spring from the rings near the head of the caterpillar.

The substance, called *Manna*, is afforded by several species of *Eucalyptus*, or *Gum-trees;* it exudes chiefly during summer, and is the saccharine juice of the young and tender twigs. It is said to be slightly aperient, and it was formerly a constant article of food with the natives, who still eagerly devour it, as do the children of the white settlers. A bottle of this Manna is exhibited.

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I must not omit to mention two beautiful and well-displayed collections of Algæ, sent by Mr. and Mrs. Fereday and by Mr. Propsting. There are also sections of Tree-Ferns, and specimens of superior Wheat, Oats, Hops, and Capsicums. Also Baskets, made by native women, of *Lepidosperma gladiatum.*

In this class a Silver Medal was awarded to Sir Wm. Denison and to the Executive Committee of Van Diemen's Land.

Canada.

IX.—CANADA.

(Special Commissioners: Messrs. W. E. Logan and J. C. Taché.)

Canada collection: the Trophy: also a series of the useful woods.

To aid the examination of this noble collection, (including the magnificent Timber Trophy), the Jury received a catalogue of the articles, arranged according to the Classes of the Exposition; and attention was immediately directed towards the extensive suites of Woods. One series, contributed by Mr. A. Dickson, consists of rather small and uniform specimens, 64 in number, in the Gallery of the Annexe. In the area of the same building stands a large pyramidal *Trophy*, composed of very noble planks (longitudinal sections), and blocks (transverse sections), 36 in all; upon most of them, the names, Canadian and Botanical, are distinctly inscribed.

The 64 smaller samples were all collected, prepared, and named by Mr. Andrew Dickson, and one half of them are from an area of only 100 acres. In the catalogue they are arranged according to their natural Families (of which there are 16), as follows:

Magnoliaceæ.

Liriodendron tulipifera. Tulip tree.

Tiliaceæ.

Tilia Americana. Lime, Bast-wood.

Anacardiaceæ.

Rhus typhina. Sumac.

Aceraceæ.

Acer saccharinum. Sugar Maple, and 3 varieties, the Rock, the Curled, and the Bird's-eye Maples.

A. dasycarpum. Soft Maple.

Amygdaleæ.

Prunus Americana. Wild Yellow Plum.

Cerasus Pennsylvanica. Red Cherry.

——— *serotina.* Black Cherry.

——— *Virginiana.* Choke Cherry.

Pomaceæ.

Cratægus punctata. Apple Thorn.
——— *coccinea.* Red Thorn.
——— *Crus-galli?* White Thorn.
——— *cordata.* Washington Thorn.
Pyrus Americana. Mountain Ash.
Amelanchier Canadensis. Service

Cornaceæ.

Cornus florida. Cornel.

Oleaceæ.

Fraxinus Americana. White Ash.
——— *sambucifolia.* Black Ash.
——— *pubescens?* Rock Ash.
——— *juglandifolia?* Rim Ash

Lauraceæ.

Sassafras officinale. Sassafras.

Ulmaceæ.

Ulmus Americana. White Elm.
——— *fulva.* Red Elm.
——— *racemosa?* Rock Elm.
——— ? Gray Elm.

Juglandaceæ.

Juglans cinerea. Butter nut.
——— *nigra.* Black Wallnut.
——— var. Soft Wallnut.
Carya alba. Shell-bark Hickory.
——— *tomentosa?* Smooth-bark Hickory.
——— *glabra.* Pig nut.
——— *amara.* Bitter nut.

Cupuliferæ

Quercus alba. White Oak.
——— *bicolor.* Swamp White Oak.
——— *rubra.* Red Oak.
——— *nigra.* Black Oak.
Castanea vesca. Chestnut.
Fagus ferruginea. White Beech.
Carpinus Americana. Blue Beech, or Hornbeam.
Ostrya Virginica. Iron wood.

Betulaceæ.

Betula papyracea. Paper Birch, or Canoe Birch.
——— *excelsa.* Yellow Birch.
——— *lenta.* Cherry Birch.
——— *nigra.* Black Birch.

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Salicaceæ.

Salix nigra. Black Willow.
Populus tremuloides. Aspen.
——— *grandidentata.* Large-toothed Aspen.
——— *balsamifera.* Balm of Gilead.
——— *monilifera.* Cotton-wood, or Necklace Poplar.

Platanaceæ.

Platanus occidentalis. Button-wood, or American Sycamore.

Coniferæ.

Pinus rigida. Pitch Pine.
——- *resinosa.* Red Pine.
——- *mitis.* Yellow Pine.
——- *Strobus.* White or Weymouth Pine.
Abies balsamea. Balsam Fir.
—— *Canadensis.* Hemlock Spruce.
—— *alba.* White Spruce.
—— *nigra.* Black Spruce.
Larix Americana. Larch, or Tamarack.
Thuja occidentalis. Arbor-vitæ, or White Cedar.
Juniperus Virginiana. Red Cedar, or Savin.

The above series is considered to represent the useful Trees of Canada. They are remarkable for the many purposes to which they are applied, and for their large commercial export, especially to England, whether as timber or in the shape of staves for cooperage; also for the fact of their being easily seasoned, and not liable to split or suffer from dry weather.

The Trophy: its woods.

The larger specimens, forming the Trophy, were collected by John Sharples, Esq., of Quebec, and the list of them is accompanied by brief remarks on their uses, as follows:—

Six Planks of *Yellow Pine* and *Kamouraska* or *Sea Board Pine*, (varieties of Pinus mitis).

Plank of *Red Pine* (Pinus resinosa).

Black Spruce Deals (Abies nigra), 2 specimens; a wood of good quality.

Tamarack, also called *Hackmatack*, known in England as Larch and Juniper (Larix Americana), an excellent wood, much used for shipbuilding.

Butternut, boards of, sometimes called Grey Wallnut (Juglans cinerea), extensively employed for furniture.

Black Wallnut Veneers, bordered with Bird's-eye Maple, and veneered on Butter-nut.

Hickory (Carya alba). Much employed for ship building.
White Oak (Quercus alba). Ditto.
Grey and *Red Oaks.* Ditto.

Beech (Fagus Americana).

Ironwood (Ostrya Virginica).

Rock Elm (Ulmus Americana). A splendid wood of large dimensions, used in ship building.

Grey and *Swamp Elms.*

White Ash, also *Grey* and *Black Ash.* A tough and valuable timber, obtainable in large quantities, except the first, which is somewhat scarce.

Black Birch (Betula nigra). Used for furniture and ship building.

White, also called *Canoe Birch* (B. alba). The wood applied to the same purposes, the bark for making canoes and covering houses.

Basswood boards (Tilia Americana). The chief material for coach panels in Canada, as it does not warp or split, and takes a high polish.

Rock Maple (Acer saccharinum). Used for furniture.

Curled and *Bird's-eye Maples*, 4 specimens. Chiefly for veneer; one roll of Bird's-eye veneer, cut by Mr. St. Arnaud at Quebec, is exhibited; it is 30 feet long and 21 inches broad.

Woods of the Trophy, —fine, but destitute of novelty.

Interesting, as it doubtless is, to see in Europe so fine an assemblage of Canadian Timbers collected at one spot, there is, nevertheless, no novelty; nor have the exhibitors, so far as I can perceive, detected any new properties in them or new uses for them. Other samples of woods, and some of them excellent specimens, are contributed by Messrs. Farmer and De Blaquière (57 kinds), by Mr. Wm. Kennedy, Mr. St. Arnaud, &c.

Gums, Sugar from Maple, &c.

General Vegetable Products, in the wild state, in this collection are, as from most northern regions, few. They are chiefly *Canada Balsam*, the natural exudation from the knots of *Abies balsamea* (fine samples); *Potash* and *Pearlash*, (apparently of good quality, but which require to be compared with others from elsewhere); and *Sugar*, from the *Maple* (Acer saccharinum). The latter well known preparation from the sap of the tree is made universally by the farmers and settlers in the woods, during the spring of the year, and chiefly for home consumption; it is generally preferred above West India sugar, and is used unrefined, formed into cakes and lumps in moulds. Recently, Messrs. Redpath, of Montreal, have subjected this substance to the refining process; and their sugar will bear comparison, to the eye at least, with the produce of the cane, and its taste is very good.

Pharmaceutical preparations.

Lastly, I have to mention a considerable collection of native *Pharmaceutical preparations*, beautifully dried, and

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arranged in bottles, bearing the botanical and colonial names. As may be expected, they are very similar to those of the northern United States, with which the plants of Canada are nearly identical.

An interesting little volume, entitled "Esquisse sur le "Canadie, considéré sur le point de vue Economiste, par "J. C. Tache, Membre du Parlement Canadien, et Com- "missaire du Canadie à l'Exposition Universelle. Publiée "par ordre du Comité Executif chargé de l'Exposition "Canadienne siégeant à Quebec," gives an excellent account of the Natural History resources of the Colony, and is freely distributed.

In this Class, a Silver Medal was awarded to Mr. Andrew Dickson, and Bronze Medals to Messrs. Farmer and De Blaquière, and to Mr. J. Sharples.

Cape of Good Hope.

X.—CAPE OF GOOD HOPE.

Cape of Good Hope collection: specimens few, but well named.

A very extensive and important Colony, whose productions are extremely inadequately represented in the Great Exhibition. The collection is meagre (as regards Vegetable Products) and of trifling value, being wholly confined to small specimens of woods, which are smoothed and polished, and some walking-sticks, and to a collection of the native medical plants of the colony. Both the one and the other are, however, very correctly named by Messrs. Pappe and Zeyher, who have distinguished themselves by their botanical knowledge, and who would undoubtedly, if they had been encouraged by the authorities, have largely aided in making known the resources of the Colony.

The woods are about 80 in number, and may, perhaps, be considered to represent fairly the familiar kinds of the Cape Colony.

Fortunately, Dr. Pappe, a resident physician at Cape Town, published in 1854 a useful little pamphlet, entitled "Sylva "Capensis, or a description of South African Forest-Trees "and Arborescent Shrubs, used for technical and economical "purposes by the Colonists of the Cape of Good Hope." Here, 77 kinds are arranged and distinguished by their botanical characters; the average size of each tree is given, and accompanied by remarks on the properties and uses of the wood. Although none of these trees can vie for beauty of wood and usefulness for cabinet-work and ornamental purposes with those of South Australia, British Guiana, and Algeria, yet the majority are handsome, and there is a considerable uniformity of merit, and in the necessary qualifications of hardness, compactness, and capability of taking a good polish.

It is to be regretted that the copies of the above-named pamphlet, which lay enclosed in the glass cases of the collection, were inaccessible to visitors and even to the Jury till the very close of the Exhibition. As the species, however, are carefully named by Dr. Pappe, and correspond with those of the present collection, I gladly avail myself of that gentleman's botanical knowledge, and extract the following brief notices from his little work :—

Dr. Pappe's description of the principal useful Cape trees.

Capparis albitrunca, Burchell, (Witgatboom). The trunk looks as if white-washed, whence its vernacular name. Bark and wood are alike pure white ; the latter is tough, and used for yokes, &c.

Phoberos Mundtii, W. Arnott, (Klipdoorn). A tree about 30 feet high; its wood is hard and close, and valued for making waggons.

P. Ecklonii, W. Arnott, (Roodpeer). Wood hard and heavy, takes a good polish, and almost rivals mahogany for furniture.

Dovyalis zizyphoides, E. Meyer. Wood citron-yellow, hard, and used for waggons and various rural implements. The sourish fruit, called *Kaffer-pruim* by the colonists, affords a kind of brandy and vinegar.

Kiggelaria Africana, L., (Speckhout). Wood soft and spongy, but sometimes used for spars, &c.

Grewia occidentalis, L., (Kruysbesje). A climbing shrub, of which the wood, though small, is fine-grained and bends readily, so that the Bushmen prize it for bows.

Ptæroxylon utile, Ecklon and Zeyher, (Nieshout, or Sneezewood). The property of this wood to affect sawyers with violent sneezing when employed upon it, has given the name. It is handsome, durable, takes a good polish, and is employed for furniture and agricultural utensils. Being little injured by moisture, it is a good timber for mills and bridges. It is also said to ignite readily, even when green.

Pappea Capensis, Eckl. and Zeyh., (Wilde Pruime). The wood is handsome, and used for furniture, ploughs, &c. The fruit is red and pleasant ; it affords a vinous beverage and good vinegar, and its kernel contains an eatable and slightly purgative oil. This tree is said to indicate the vicinity of good pasturage for flocks of sheep.

Eckebergia Capensis, Sparrman, (Essenhout, Cape Ash). Wood white, tough, and used for beams, carriage-poles, waggon-work, &c.

Calodendron Capense, Thunberg, (Wilde Kastanie, Chestnut.) Wood soft and nearly valueless. The strong-scented flowers resemble those of the Horse Chestnut.

Fagarastrum Capense, Don, (Knobhout). The name

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among the colonists is derived from the large conical protuburances on the bark; the wood is hard and yellow, used for domestic utensils. The fruit is called *Wild Cardamom*, and prescribed for flatulency and paralysis.

Asaphes undulata, D.C., (Wit Yzerhout, White Ironwood). Wood white and hard, used for axles, &c.

Ochna arborea, Burch., (Rood-hout, Redwood). Wood red and hard, suitable for furniture, but chiefly employed for the handles of agricultural implements.

Celastrus acuminatus, L., (Zybast, Silk-bark). Bark and leaves remarkable for the numerous fine silky threads which they show when broken. Wood, fine and hard, beautifully shaded when polished, and very splendid in ornamental joinery; it would suit well for the manufacture of musical instruments.

C. rhombifolius, Eckl. and Zeyh., (Pendoorn). Wood hard, close, and yellow like box, used by Turners, also for musical instruments, as flutes and clarionets.

Pterocelastrus typicus, Meissner, (Spekboom). Wood soft, light, and used for charcoal.

P. rostratus, Meissn., (Witpeer). Wood like that of the pear-tree; used for waggon work.

Hartogia Capensis, Thbg., (Lepelhout, Ladlewood). Wood hard, fine-grained, and surpassing when polished the finest mahogany, invaluable for veneering and turnery.

Elæodendron croceum, D.C., (Saffraan-hout, Saffron-wood). Name derived from the conspicuous saffron-yellow resinous crust, which covers the bark. Wood fine-grained and hard, used by builders and cabinet-makers; the bark is good for tanning and dyeing.

Cassine Maurocenia, L. A small shrub; the wood is fine, and when polished is yellow streaked with brown; it would answer well for musical instruments.

C. Colpoon, Thbg., (Lepelhout). Wood hard and handsome, adapted for fancy cabinet-work.

Rhamnus celtifolia, Thbg., (Camdeboo, Stinkhout). Wood yellowish and tough, used for planks, yokes, axe-handles, and cooper's work.

Scutia Capensis, Brongn. (Katdoorn). A shrub; branches armed with hooked thorns, wood fine-grained and strong, useful for turnery.

Heeria argentea, Meissn., (Kliphout, Klipesse). Wood resinous, fine-grained and heavy, very handsome, marbled like the maple when polished, and well adapted for fancy furniture, ornamental boxes, and musical instruments, &c.

Rhus viminalis, Vahl, (Karreehout). A small, willow-like tree, with grey smooth bark and reddish-brown pliable

wood, which recommends the larger branches for waggon tents and the young twigs for bows; the wood, too, never harbours insects.

Rhus lævigata, L., (Taaibosch). A small tree, only a few feet high; the wood is used for waggon-work, and being hard and tough would suit the Turner.

R. tomentosa, L., (do.) Root and bark of branches used for tanning; wood hard and tough.

R. lucida, L., (do.) Same qualities as the preceding.

Virgilia Capensis, Lamarck, (Keurboom). A small but handsome tree, 15-20 feet high, which has diffused itself all over the Colony, from the eastern provinces of which it is a native; the bark is black and rough; wood light and soft, pretty when polished, but liable to be worm-eaten; it is used for yokes, spars, &c.

Erythrina Caffra, Thbg, (Kaffirboom, Kaffirs' tree). This tree, attaining a height of 50 or 60 feet, is termed the giant of Kaffrarian forests; its bark is grey, and the wood soft and light, and the trunk is therefore prized by the inhabitants, who hollow it into troughs and canoes, and use it instead of cork for their nets; when the timber is tarred, it is said to make durable roofs.

Acacia horrida, Willdenow, (Doornboom, Thorn tree). Wood hard and tough, improved by steeping before it is used for furniture; the bark is good for tanning leather, and gives it a reddish colour. *Gum Acacia* exudes spontaneously from the trunk and boughs, and is a well-known article of commerce. The appearance from afar of this tree is eagerly hailed by the traveller in the scorching South African deserts, as indicating the existence of water.

Schotia tamarindifolia, Afzelius, (Hottentots' Boerboom) Wood reddish-brown, tough, and durable, employed for yokes, &c.; the bark is brown and rugged, and the beans or fruit are eaten by the natives.

S. latifolia. Same qualities as the preceding; a taller tree, 20-30 feet high.

Olinia Capensis, Klotzsch (Hardpeer). Wood very compact and heavy, fit for making musical instruments, picture-frames, and fancy-work, and valuable to waggon-makers.

O. cymosa, Thbg. A smaller tree, but with similar qualities of wood.

Cunonia Capensis, L., (Rood-Els). Wood tough and close, resembling that of the Linden, and in much request by cabinet-makers and wheel-wrights; not injured by damp.

Weinmannia trifoliata, L., (Wit-Els). "A stately tree" (23-30 feet high), wood lighter than the preceding, but used for the same purposes.

Curtisia faginea, Aiton, (Hassagay-Hout, Assagai-wood). The most valuable wood in the Colony for strength and durability, and highly prized for making the waggons, which afford almost the only means of locomotion, and which often travel immense distances and over very difficult ground.

Trichocladus crinitus, Persoon, (Onderbosch). The very tough branches and twigs of this shrub are used for hoops, baskets, &c.

Burchellia Capensis, D.C., (Buffeldoorn). A small tree, the wood of which is very hard, and employed in making agricultural implements.

Gardenia Thunbergia, L., (Buffelsbal, Wilde Katjepiering). Wood hard and strong, used for tools, clubs, yokes, ploughs, &c.

G. Rothmannia, L., (Zwarthout). Wood hard, strong, and tough ; used for the same purposes as the foregoing species.

Plectronia ventosa, L., (Schapendrolletjes). Wood close and hard, takes varnish well, and looks handsome and marble-like ; it is suited for small fancy furniture ; the fruit, though tasteless, is eaten by the natives.

P. Mundtiana, Pappe, (Kloofhout). A shrubby tree ; the hard white wood is used for turnery.

Tarchonanthus camphoratus, L., (Siriehout, Wilde Salie). A small tree, 8 feet high ; the wood is handsome when polished, and adapted for joiner's work. The fresh leaves smell like camphor, and are chewed by the Mahomedans and smoked by the Hottentots, and used in infusion or tea as antispasmodic, tonic, and resolvent.

Philippia Chamissonis, Klotzsch, (Kabinet-hout). The wood is much valued by cabinet-makers and turners.

Royena lucida, Thbg., (Zwartbast). The black bark gives the name to this small tree, of which the wood is hard, yellow, and striped with brown ; it is used for tools, furniture, waggon-work, &c.

R. glabra, L. Wood light and porous ; valueless, except for fuel.

Euclea racemosa, L. Wood hard and heavy ; used for screws and fuel.

E. undulata, Thbg., (Guarrihout). Of similar height to the preceding, 6 feet ; the wood is brown, close-grained, and fit for fancy work. The natives eat the berries.

Sideroxylon inerme, L., (Melkhout). Name derived from the milky bark ; wood yellow, durable, and so little affected by moisture as to be much valued for boats, mills, and bridges. The fruit is eatable, and called Jackal besjes.

Myrsine melanophleos, R. Brown, (Beukenhout). Wood tough and employed for waggon work.

Myrsine? mitis, Sprengel. Wood spongy and little worth.

Olea verrucosa, Link, (Olyvenhout). One of the best woods in the Colony for density and hardness, it lasts longer than iron, looks handsome when polished, and is admirably adapted to all kinds of machinery, furniture, &c. The tree strongly resembles the European olive, which might, probably, be successfully grafted upon it.

O. laurifolia, Lamarck, (Zwart Yzerhout, Black Ironwood). Wood dark, close-grained, and heavy, used by cabinet-for all kinds of furniture, and by farmers for tools, ploughs, &c.

O. Capensis, L., (Ironwood). Wood compact, heavy, and used for wheels and poles of waggons.

Secamone Thunbergii, E. Meyer, (Melktouw). A milky juice oozes from this shrub; its stem climbs to the tops of the tallest trees, and is used like ropes by the baboons to convey themselves when seeking for food or escaping from danger; the natives use it as we do the willow, and call it *Baviaanstouw* or *Baboon's rope*. The wood is white and hard, but very small.

Gonioma Kamassi, E. Meyer, (Kamassichout). Wood yellow, with whitish flames, hard, close-grained, one of the finest and heaviest in the Colony; useful for furniture and veneering, for making tools for carpenters, and ploughs, &c. The flowers are delightfully scented.

Halleria lucida, L., (Witte Olyve). A very small tree, only about 6 feet high, with a fine-grained wood, useful for small articles which demand strength and durability, as screws, planes, &c.

Buddleia salviæfolia, Lamarck, (Saliehout). An excellent hard wood, much used by the Colonists, also by the Kaffir chiefs and warriors for javelins or assagais.

Chilianthus arboreus, Burch., (Wilde Vlier). Hard and tough wood, employed for common furniture.

Oreodaphne bullata, Nees, (Stinkhout). A beautiful tree, from 20 to 35 feet high, the *African Oak** of Mr Barrow; its wood has a disagreeable smell when cut; it resembles wallnut, and is used for gun-stocks and superior furniture; vermin will not approach it. Where the tree is allowed to attain its full height, as at the Knysna river, it is employed for ship-building; but the wantonly destructive practice of firing the forests, especially on Table Mountain, every year, ruins the good timber, besides inflicting the serious damage of lessening the already too small supplies of

* The true *African Oak* (from Western tropical Africa) of commerce is Oldfieldia Africana of Bentham and Hooker.

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water. Under the Dutch government heavy penalties were attached to this outrage, which was denounced as arson.

Leucadendron argenteum, B. Br., (Witteboom, Silvertree). Wood soft and spongy, liable to be attacked by insects. The tree is highly ornamental and conspicuous.

Protea grandiflora, L., (Wagenboom). A small tree, useful for many purposes. The wood is beautifully grained and of a pretty colour; the bruised leaves, saturated with water and iron, produce a black and fairly good writing ink; the bark is a powerful astringent, valuable in diarrhœa and affording the best tanning.

Leucospermum conocarpum, R. Br., (Kreupelboom). Wood reddish, looking well when varnished, and used for charcoal; the bark is excellent for tanning skins, and its decoction is a powerful astringent.

Brabejum stellatifolium, R. Br., (Wilde Almandelboom, Wild Almond). Wood red, reticulated, very ornamental for joinery and cabinet-work; the bark contains a powerful tanning principle. The fruit, which is a drupe with a velvety covering, much resembles the almond; the natives eat it after many days' soaking in water, as they attribute noxious qualities to it when fresh, the roasted kernel serves for coffee.

Fusanus compressus, L., (Pruimbast). Wood heavy and fine-grained, fit for fancy-work, and the bark useful to the tanner.

Urostigma Natalense, Miquel. The wild fig-tree of the Hottentots, who call it t'Kaa. The wood is light and porous; the fibres of the bark make serviceable ropes.

Salix Gariepina, Burch., (Wilgeboom, Willow-tree). The wood is light and soft, of small value; the larger boughs are used in house-building, the smaller ones for baskets. The tree much resembles a weeping willow.

Widdringtonia juniperoides, Endlicher, (Cedarboom). A valuable tree, which attains a considerable size in time, for it grows slowly, and the cupidity of cabinet-makers &c., causes it to be too often felled when young, so that it is, unfortunately, fast disappearing on the Cedar Mountains, to the great regret of well-wishers to the country. The annual conflagrations act their part in destroying this ornament of the Colony, which used to be very abundant. The timber is very valuable for many purposes; and a gum exudes from the branches and cones which has medicinal virtues, and is allied to *Gum Olibanum*, and is considered particularly effective in the treatment of gout, rheumatism, &c.

W. cupressoides, Endl., (Sapreehout). A light wood, used for cooperage, especially pails.

Podocarpus elongatus, L'Héritier, (Geelhout). Extensively used for planks and beams, and for all kinds of joinery; its tall stem is excellent for masts of ships.

P. Thunbergii, Hooker, (Kaapsche Geelhout, Cape Yellow-wood). The wood is lighter than and inferior to that of the preceding species, and only employed for common furniture, &c.

Niebuhria Caffra, D.C., (Witbosch-hout). A light, tough, white wood, adapted for agricultural implements, &c.

Eugenia Zeyheri, Harvey, (Wilde Jambos). Wood white, hard, heavy, and fine-grained, fit for ploughs, axles, &c.

Halleria elliptica, Thbg., (Oudehout). Wood yellowish and tough, though soft; it is chiefly employed for ploughs, &c.

Canthium? (Kaapsche Kajatenhout, Cape Teakwood). The yellowish hard wood serves to make rural utensils, and is largely employed in Coopers' work.

The pamphlet,* from which I have made the above extracts, contains an Appendix with a very interesting account of the *Cape Wax-berry Myrtle* (Myrica cordifolia), and the best mode of collecting and preparing the wax, as a source of profit. None of the wax, however, is exhibited; and the prolonged absence of the Commissaire for this department forbade my Class from obtaining any further information about this curious substance, which is the more to be regretted as vegetable waxes are now much in demand.

There is a handsome box of inlaid Woods of the Cape Colony, consisting of 24 kinds, accompanied by a diagram and names.

Except the Woods, all the Cape of Good Hope collection is very uninstructive, and conveys no adequate idea of the useful Vegetable Products of the Colony.

The Pharmaceutical Plants are carefully dried and preserved in bottles, with the names only (no remarks) attached. They are 41 in number, and are as follows:—

Its pharmaceutical products.

Ballota Africana.	Leysseria gnaphalioides.
Artemisia Afra.	Ornithogalum altissimum.
Monsonia ovata.	Elytropappus Rhinocerotis.

* Dr. Pappe renders justice to S. Hartman, Esq., M.L.A., for his valuable communications respecting the useful trees of the Eastern Province; to John Schenble, Esq., of Cradock, for specimens of the most valuable woods, from the Uitenhage District; and to C. Zeyher, Esq., whose experience and practical knowledge of the Cape Flora are only equalled by his modesty.

Since the above was written we have been favoured by Dr. Pappe with another of his interesting pamphlets, entitled "Contributions to the Cape Œconomic Flora," from the Cape of Good Hope Almanack and Annual Register for 1856, in which 25 plants are described, and their officinal properties recorded. This may be considered a supplement to his useful "Floræ Capensis Medicæ Prodromus," being an enumeration, with descriptions, of the Medicinal Plants indigenous to the Cape Colony.

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Pelargonium cucullatum.
Diosma crenata.
Cliffortia ilicifolia.
Leonotis Leonurus.
Arctopus echinatus.
Osmatopsis asteriscoides.
Melianthus major.
Pilogyne Eckloni.
Viscum Capense.
Leontonyx angustifolia.
Bubon Galbanum.
Pelargonium, sp.
Cassytha filiformis.
Matricaria globosa.
Cissampelos Capensis.
Hæmanthus coccineus.
Citrullus amarus.
Helichrysum serpyllifolium.
Helichrysum auriculatum.
Tanacetum multiflorum.
Mohria thurifraga.
Pelargonium anceps.
Aloe ferox.
Garuleum bipinnatum.
Homeria collina Sw. (in a small box, like roots of Ixia).
Salvia Africana.
Lyperia crocea.
Adiantum Capillus Veneris.
Ricinus lividus.
Adiantum Ethiopicum.
Mundtia spinosa.
Ranunculus pubescens, Th.
Hydrocotyle Asiatica.
Hyænanche globosa

In this Class a Bronze Medal was awarded to the Colony of the Cape of Good Hope, and to Messrs. Pappe and Zeyher.

French Colonies.

XI.—THE FRENCH COLONIES (exclusive of ALGERIA.)

(Administration of the respective Colonies.)

French Colonies (not Algeria) collection: hardly available to the jury.

Several attempts were made to inspect this collection in such a way as to derive instruction from it, but without success. There was no catalogue; the Commissaire was, apparently, without a bureau, and the person who acted in that capacity was destitute of any knowledge whatsoever of the objects exhibited. At length on the last day of July, a gentleman presented himself with an imperfect MS. catalogue: it contained the scientific names of some of the articles, but the difficulty of finding them was extreme, for there was no classification, even into countries! And the arrangement, if such it could be called, of the objects, did not correspond with the catalogue; and the attendant was unable, in several instances, to refer from the one to the other. Martinique, Guadaloupe, Guiane Française, Isle Réunion, Senegambie (and Gabon), India (Pondicherry),—all have their products indiscriminately placed, as best suited the tables which they occupied. The collections profess to be furnished by the Administrations of the respective Colonies. Still it is obvious that under the circumstances which I have described, it was impracticable to arrive at any correct conclusions, either as

to the scientific or commercial value of the objects, or the Vegetable resources of their respective countries.

In proof that the above strictures, written on the spot, are not too severe, I quote the excellent "Visite à l'Exposition," published under the direction of the distinguished M. Tresca, principal Inspector of the French Exhibition in London in 1851, and "ancien Commissaire du "Classement à l'Exposition de 1855." He writes thus:- "La pauvreté et le petit nombre des échantillons envoyés par "nos Colonies, a conduit, sans doute, au systême de classifi- "cation que nous avons vu en vigueur dans cette partie de "l'Exposition. Tous les produits réunis, agglomérés, sans "distinction du pays, qu'ils venaient des Antilles ou du "Sénégal, de la Guyane ou de la Réunion, forment, sans "doute, un ensemble assez satisfaisant au premier coup "d'œil; mais cette confusion augmente énormément les diffi- "cultés d'un examen serieux. Il nous semble qu'il eut été "plus digne, et en même temps plus utile, de montrer "franchement nôtre pauvreté; plus elle aurait été evidente "et palpable, et plus vîte on se serait occupé de la détruire. "Il est difficile de guérir quand on cache son mal." And the Count Jaubert, in "La Botanique de l'Exposition Universelle de 1855," expresses himself to the like effect. "On "se demande, au premier abord, si nos Colonies n'ont rien "de plus à nous présenter, que ce que l'on voit etalé ici "sur une table et sur la tablette à côte. Des nattes, des "paniers, des chapeaux, des modèles de pirogues pourraient "peut-être nous arrêter davantage, si nous savions toujours "quelles écorces, quels bois, ont servi à les fabriquer," &c.

The MS. Catalogue, to which I have above alluded, gives, without one word of comment, the bare names, local and botanical, of the following list "Des produits obtenus sans culture."

I. Isle de la Reunion.

262 Samples of *Woods*, sent by the Administration, alphabetically arranged in the list.

10 Samples of *Textile Plants*, viz., *Fibre d'Aloes, d'Agave, Feuilles de Vacona, de Bananier, Fil de Passe-rose, Crin Végétal de Palmier, Coton indigène, Soie végétale, Ouara* (*Astrocaryum vulgare.*)

21 *Medical Plants*, of little note.

II. Senegal.

10 *Woods*, with the native names (no others).

Gum, from Senegal.

III. Gabon (Coast of Africa).

6 Miscellaneous Objects, viz., *Bois de Santal* (probably very different from the Sandal-wood of commerce), *Camwood, Gum, Ouara* (*Astrocaryum vulgare?*), *Fil d'Ananas, Cire de Gabon.*

IV. La Guiane Française.

Towards the close of the Exhibition, I was favoured with a copy of two Nos. of the "Revue Coloniale," for July and August 1855, from which the following information upon objects derived from French Guiana is gleaned :—

Bark of the Maho (Lecythis grandiflora). It flakes off the trunk in large, thick, long pieces, formed of layers of fibre, and is used for making baskets. (Many other barks are called Maho).

Bark of the Maho (Lecythis Zabucajo). Detached in very thin pieces, it serves to contain tobacco and to make cigarettes, its own aroma being considered to improve the flavour of the cigar. It is only employed by the Indians of French Guiana.

Moncon Moncon (Caladium giganteum). The tall stems of this aroid afford a fibrous substance, which is probably convertible into paper; the plant abounds in all damp places fringing the river-banks in Guiana. Many climbing plants, as Hunter's Vine, Monkey Vine, and numerous others, might be procured in enormous quantities for making coarse paper.

Arouma (Maranta). Its bark serves the Indians for baskets, sieves, and many such articles.

Ouara Straw (Astrocaryum vulgare). A palm tree, called Ouara, affords, in its young foliage, the material for straw hats and fans and brooms.

Curatella Guianensis, a shrub; it bears such rugged leaves that they are commonly employed by cabinet-makers for polishing wood.

Bucida Buceras, the French Oak of the Antilles, is useful in tanning, and the wood is valued by carpenters, as worms do not attack it.

Tonka Bean, also called Gayac Bean, the seed of *Dipteryx odorata*, is used for perfuming clothes and snuff; its peculiar principle is termed Coumarin.

Pareira Brava (Cissampelos Pareira), to which many names, as Our Lady's Plant, Snake Vine, Bitter Vine, &c., are given, is a well-known tonic and diuretic.

Sarsaparilla (Sarsaparilla officinalis). The Guiana plant, which is largely collected and sold by the Indians at Para, is considered as efficacious as that from Honduras.

Mangrove Bark (Rhizophora Mangle). A valuable febrifuge in the Antilles; the bark is employed for tanning.

Vomit-vine (name unknown). Used as an emetic.

Red-wood bark (Bursera balsamifera). The secondary bark gives out a healing resin which is called Balm Houmiri.

Quassia (Quassia amara). A common shrub in Guiana; its bitter bark is useful in dysentery, and has often been substituted for hops in brewing both in England and Holland.

Ouabi oil (Omphalea diandra). A fatty matter is easily procured by pressure from the seed, and a clear, yellow, brightly-burning oil is extracted. The plant is much grown in Guiana.

Comou oil (Œnocarpus Bacaba). It is extracted by crushing and filtering the pulp of the fruit; the taste is pleasant, the colour greenish, and there is no doubt it might serve for food.

Yayamadou. From the seeds of the Virola a greasy substance is obtained, which much resembles wax; it is yellowish, tasteless and burns well.

Gum Elemi (Icica heptaphylla), called also Cayenne Incense, Tacamahaca, &c., is used as a perfume and an astringent, and for burning in churches.

Gum Cashew (Anacardium occidentale), exudes from incisions in the bark, and is a chief ingredient in varnishes; the fruit makes vinegar and brandy; the kernel is eaten raw and baked, and is alleged to improve the memory! The yellow and caustic juice of the nut removes corns and warts, and the oil of the kernel is employed by painters.

Gum Mani (Moronobæa coccinea). The whole tree affords a resin, which has the qualities of pitch and tar.

Gum Courbaril (Hymenæa Courbaril). Used for varnish, and administered in catarrhs; the wood is esteemed for cabinet-work.

Gum Elastic is a substance which partakes of the qualities of Caoutchouc and Gutta Percha, and is the produce of a species of Fig-tree which abounds in Guiana. Its discovery promises useful results.

Gum Gutta (Hypericum bacciferum). The congealed sap of this tree bears the above name in America, and is prescribed in skin diseases. In warm water it dissolves into a beautiful yellow colour, which may serve to dye silken stuffs.

Coumaté Varnish, the produce of one of the Myrtaceæ. It is applied, both cold and warm, to white woods, and when many times repeated, it gives a beautiful gloss and colour, which are quite permanent, and which a slight rubbing with grease restores to their pristine hue and polish.

Aya-pana (Eupatorium Aya-pana). The Tea of the River

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Amazons, and considered an agreeable stomachic; a universal specific.

Carmentin (Justicia pectoralis). A healing syrup is made from its foliage, which is also used as a cataplasm.

Pitre (Bromelia Pigna). In Guiana, as in many other Tropical countries, the silky white fibres of this plant are employed to make fishing-lines, nets, hammocks, &c. They would probably be available for the manufacture of paper.

Bancoul Nut (Aleurites ambinux). The kernel, when baked and deprived of the embryo, is good to eat, and affords a palateable oil.

Cocoa-nut Oil. Emollient, purgative, and a vermifuge. The expanded flowers are pectoral, and if bruised when in blossom they yield a pleasant beverage, which quickly turns to a strong vinegar. The milk of the Cocoa-nut is very agreeable in a fresh state, and after fermentation, becomes vinous and alcoholic.

A country (where?) bearing the title of "*Océanie Française*," exhibits very beautiful *ornaments* or *head-dresses* made of the strips of the flower-stalks of "*Maranta.*"

In the French Colonies a Silver Medal is awarded to M. Bélanger, and a Bronze Medal to M. Descoublanc and M. Pecoul, and to M. Prurièr and M. Raboutet, Martinique; a Silver Medal to M. Philibert, of French Guiana; Bronze Medal to the Administration de la Guadeloupe and to that of the Isle de la Réunion; Bronze Medal for the "couronne" or head-ornament of Océanie Française, and to M. Ventray, for Vanilla.

Netherlands.

XII.—NETHERLANDS (principally the INDIAN COLONIES.)

(Commissioner: Mr. J. P. Pescatore.)

Netherlands (Colonies) collection: numerous articles, a Trophy, &c.

To this portion of the Exhibition, occupying a considerable space, and consisting of a Trophy,* as well as Tables and Cases,

* This *Trophy*, the most conspicuous object in the Annexe, and which appears to us mainly to consist of empty boxes and barrels, or with only a portion of the mercantile contents seen at the opening, and which it must be allowed quite answered the purpose, is thus graphically described in Tresca's "Visite à l'Exposition Universelle de Paris, en 1855,"—"Le trophée, qui réunit dans l'axe de l'Annexe toutes ces récoltes des Colonies Néerlandaises, traduit bien le caractére du pays et du people. Ces caisses, ces tournes, ces ballots n'ont pas été préparés pour le jour de l'Exposition; se sont les enveloppes habituelles dans lesquelles le commerce Hollandais livre au monde les produits de son sol colonie. On y sent la mer, le goudron, tous les parfums du bord. Il semble que le navire vient d'entrer dans le port et qu'on vient de vider la cale sur le pont; de ce tonneau défoncé s'echappent par milliers les noix du muscadier; cette caisse foncée montre les magnifiques cylindres de la canelle; ce barril ouvert jette,

the Commissaire specially invited attention and requested the Jury to fix a day for inspecting the collection. That which concerns Class II. is almost entirely confined to objects from the Indian Archipelago, placed in the gallery of the Annexe.* They are exceedingly numerous, and a catalogue was promised; but, when it was received it proved to be in manuscript and to consist solely of an enumeration of the pieces of wood, mere blocks, rarely smoothed or polished, piled one above another, and bearing the corresponding numbered Indian (Malayan) names only with the catalogue. Of the properties and uses of the woods, the catalogue said nothing, nor was the attendant better informed. All that could be learnt was, that the samples consisted of woods of Java, Borneo (amounting to 100), Sumatra, and Celebes. Adjacent is a large collection (placed without order, and rarely marked, save with a number, and now and then a local appellation,) of vegetable products unaccompanied by catalogue printed or written; and respecting which the Commissaire knew no more than he did of the woods. Even the native names were confounded, different specimens being jumbled under one name. Three

Ill-arranged, and worse named.

comme une corne d'abondance, de superbes cubes d'indigo; cet autre verse les minces feuillets de la gomme lacque. Voici du poivre, du café, du thé, des clous de girofle dans cette coupe Indienne. Cette balle eventé est tout plein des fibres du Rameh, dont un écheveau est suspendu à l'angle de cette caisse. De ce côté, s'ouvre une boîte de cigares; de cet autre, se montrent de belles feuilles de tabac d'Hollande. Il y a dans ce fouillis de richesses, dans ce chaos de matières brûts qui donnent l'existence à milles industries, une sorte de sentiment de sa valeur; cela respire l'intelligence du producteur, l'art du commerçant, l'activité de ce grand peuple autrefois le maitre des mers, qui sut si bien tirer échange de tout, encaquer ses harengs, troquer ses tonnes infectes contre des tonnes d'or."

* The origin and history of this collection is given by an English gentleman resident in Java in the Journal of the Indian Archipelago, vol. VII, p. 261, &c. "The example was set by the Crystal Palace Exhibition, of 1851, in London, and in laudable imitation, the Dutch Colonial Government of Java set about forming a collection of objects which should exhibit the natural Produce and the Industry of Java and the Indian Archipelago. The chief movers of the business were M. Schiff, Director of Culture, M. Van Rees, resident of Batavia, and M. Tromp, Civil Engineer; also, Dr. Bacher, celebrated for his knowledge of the Fauna of the Netherlands India. Aided by numerous Government officers and private individuals, these gentlemen set actively to work, stimulating the native chiefs in the several Islands to collect and transmit whatever was worthy of notice; and when the collection was deemed fit for public inspection, His Excellency the Governor of Netherlands India, D. Van Twist, opened it with great ceremony on the 10th October." Creditable, however, as such a museum is to the Dutch Governor of Java, the writer of the account, from which I have quoted, shows that it is lamentably deficient in objects of scientific and practical information. Flax from the fibres of the wild Plantain, some wax procured from the leaves of the same plant, specimens of Bamboo, measuring 2 feet in circumference at the base, and flowers of the celebrated Rafflesia, are the most noticeable articles of Vegetable Productions; for nothing can be learned from a heap of barks, fibres, rattans, seeds, fruits, leaves, marked "musters of various plants!"—The perplexed visitor is unable to extract any information from such a mass of confusion.

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Netherlands.

distinct Algæ are called Agar-Agar. Apart from this collection is the Trophy, of considerable size, made up of bales, bags, and boxes of the vegetable and other productions of the Netherlands India; here and there displaying fine specimens of Woods, Cocoa-nuts, Barrels, or Baskets of Indigo, Coffee, and other commercial articles, without name or note. But around the Trophy is a table, whereon are placed products which do bear some correct names, and a few of which are unquestionably of interest.

At a very late period of the Exhibition, M. Adriaan Van Hasselt sent a "Catalogue d'une Collection de Produits Naturels, Commerciaux, et Industriels des Possessions Néerlandaises dans les Indes Orientales, envoyée à l'Exposition Universelle de 1855." It seems to refer solely to that portion which forms the Trophy just mentioned in the area of the Annexe; for M. Van Hasselt says, that it was no easy matter to arrange the heterogeneous mass of boxes, articles of merchandize, &c, in a form which should not be utterly shapeless, and that he hopes this point has been accomplished. Also, that care was taken to exhibit nothing but the productions of the Dutch possessions in this groupe, carefully excluding such as come from the English and Spanish parts, from China and Japan.

Some valuable articles.

The following articles merit notice:

Rameh, the fibre of Bœhmeria tenacissima, rough and in several stages of preparation.

Jute, the well-known produce of Corchorus capsularis.

Fibres.

Agave fibre, or Pita, which makes excellent cordage.

Goemi fibre, from the Talipot Palm. Is woven into coffee bags in Java.

Oil of Cinnamon, now an important item of export from Java.

Oil of Nutmeg-flowers, from Moluccas, *Cajeput oil*, and *Gum oil*; the latter is said to be obtained from a sort of copal, but is of somewhat uncertain origin.

Gum Dammar, from Dammara orientalis, an Amboyna Pine: it is used to caulk ships, and to make torches, &c.

Some valuable woods.

Ebony Wood from the Moluccas (Bauhinia variegata and B. purpurea.)

Yellow Wood (Xanthoxylum montanum), which gives a yellow, green, and olive dye.

Sappan Wood (Cæsalpinia Sappan), used for dyeing red.

Amboyna Wood (Pterocarpus Draco ?), valuable for turnery and fine furniture.

Kajoe Wood, a hard and rare article, its origin unknown.

Malacca Canes and *Rattans*, white and brown, in great variety; such as are employed for the seats of chairs, &c.

Nutmegs, of different qualities, *Pepper*, *Cloves*, *Cinnamon*, *Cassia*, *Caoutchouc*, *Gutta Percha*, and *Gutta Lahoe*, (which is a waxy substance from Ficus cerifera) are all important productions: of the latter, more fully described below, and which promises to be a really valuable article, the Sumatrans make flambeaux which burn bright but cause much smoke. *Nutmeg Butter* is an article comparatively new to Europe. Spices.

The *Bark* of *Laurus Culitaban*, a large tree growing in the Moluccas and Amboyna, is employed in medicine and as a spice. *Sogah Bark* is a dye, the tree is not certainly known. My friend, Mr. Hanbury, has noticed among other samples in this collection the following (*see* Pharmaceutical Journal of London for Dec. 1855), *Turmeric* and *Ginger*, both very fine, *Brown and White Sago*, *Benzoin*, *Musk-seeds*, (Hibiscus Abelmoschus), *Oil* of *Cinnamon* (the fluid so called is colourless), Bark of *Cassia vera*, which under the name of *Figablas*, is largely imported into London, (it is probably used as a succedaneum for the more costly cinnamon bark): solid *Oil* of *Nutmegs*, *Anthophylli* (the half developed fruits of the clove), *Round* or *Clustered Cardamoms*, *Penghawar Jambie*, hairs or *hair-like scales* from a Fern, a *Cibotium* (a kind of *Scythian Lamb* of old writers), used as a styptic, specimens of the rare *Lopez-root*, marked "Morus Indica", of Nees ab Esenbeck (? (once included in British Materia Medica and still retained in that of Holland), and lastly, a coarse, sawdust-like, slightly aromatic substance from Amboyna, marked "*Storax en larmes*. qualité précieuse, introduite depuis peu en Europe," which is unquestionably referable to Styrax officinale, Linn. Barks.

The *Edible Birds' nests*, and the Alga (*Agar Agar*, of Java and Banda), which is supposed to contribute materially to the composition of these nests, must not be overlooked. The Alga is a species of *Sphœrococcus*, the *S. spinosus*, Agardh; it is manufactured into a sort of glue or jelly, and much relished in China. Naturalists are still divided upon the point, whether the gelatinous matter which distinguishes the edible nests, is not, after all, a secretion from the bird, a species of swallow. Professor Owen is of that opinion, while the French Naturalists seem generally to believe it to be prepared by the bird from some kind of Alga. Edible Birds' Nests.

The attention of our Class has indeed been directed to a peculiar substance called "*Vegetable Wax*, under the name of "*Getah-Lahoe*," accompanied by a drawing and specimens of the plant, which is a species of *Ficus* (Ficus cerifera, *Blume*), a native of the Dutch possessions in Sumatra. Specimens were handed over to the French chemists for analysis, but I am not aware that the results have been published. In the meanwhile a figure and description has appeared in the Vegetable wax.

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French "Annales des Sciences Naturelles," 4me Series, vol. 3. p. 330, the latter from the pen of Dr. Bleekrode, Professor of the Royal Academy of Delft. That gentleman's analysis, to a certain extent, is there given;—too long to be transferred to these pages, and not easy to be compressed, and his conclusion is; "La Getah-Lahoe promet de devenir un produit important pour la fabrication des bougies, même de celles où la *cire entre comme matière premiere.* J'ai commencé à en faire l'application, et les résultats que j'obtiendrai seront publiées le plus tôt possible. C'est par la pratique que doivent être confirmés les essais du laboratoire, afin qu'on puisse décider de la valeur industrielle et de l'avenir de la *Getah-Lahoe.*" It is, I believe, quite an anomaly that a species *Fig* (Ficus), should yield a wax, and even Dr. Bleekrode thinks it possible that the substance sent may not be pure from the tree: "Il y a, en même temps, une autre problême à résoudre, savoir si la cire végétale appellée *Getah-Lahoe* différe réellement des diverses espèces des cires végétales qui ont été de temps en temps importées en Europe. Il est aussi d'une grande importance de connoître l'arbre duquel la *Getah-Lahoe* s'écoule, afin d'être certain que les indigènes ne mêlent pas les differentes sortes de sucs laiteux."

Tea, Cinchona, and Camphor cultivated there.

Little as the Dutch authorities have contributed in the way of information by their contribution to the Great Paris Exhibition, they have certainly not been negligent of the true interest of their Dutch possessions in the East, in developing their resources through the aid of intelligent and scientific men. That the introduction and culture of the Tea-plant is carried out to a great and very profitable extent we all know. Naturalists in the different departments, at home and abroad, are required to direct their best energies in the furtherance of similar objects, and recent accounts have been received of the successful introduction of *Cinchona Plants* in Java. A professor, Dr. Miquel of Amsterdam, is stated to be the first to suggest the experiment, and Mr. Hasskarl, a German gentleman and able botanist, was engaged to visit the Cinchona districts in South America, to collect the best species, and convey them (living) to Java. Dr. and Professor De Vriese has published admirable treatises on the famous *Camphor Tree* of the Malay Islands; and he is, or we are much mistaken, devoting his attention to the valuable *Gutta Percha Tree*, which is known to abound in Borneo, where the Dutch have vast possessions, whose vegetable riches time and industry can alone fully develope.

Cotton, samples of, from the leaves of the Fir.

In the European portion of the Netherlands collection, there are samples of leaves, oils, and extracts; also the curious fibres, made into coarse mats and lace, white and looking like cotton,

of the *Fir* (Pinus sylvestris), and even coarse paper of the same material. These articles are contributed by Penhorst, Perous & Co. The pecuniary value of this kind of fibre is perhaps not fully ascertained.

In this Class a Silver Medal was awarded to La Société Néerlandaise de Commerce of Amsterdam; and Honorable Mention to J. von Halmael, for woods of Surinam.

XIII.—MEXICAN REPUBLIC.

(Commissioners: M. Pedro Escandon, M. Juan Agea, and M. le Conte de Brignola.)

Mexican Republic collection: over-estimated in its catalogue;

A collection which, though small, appeared to merit a more detailed notice than I could give of it in the absence of a catalogue, or of any person who could afford information, for it was not till long after the jury's work was done that the Mexican Commissaire furnished a catalogue. In it we are assured that, "L'exposition Mexicaine est celle qui, après "l'exposition des Etats Unis, offre le plus d'abondance et "le meilleur assortement des produits du Continent Ameri-"cain." This may be quite true, for it is no very great honour to stand next below the United States in the great Paris Exhibition; and this low position of Mexico may be accounted for by the unsettled state of the country. The catalogue enumerates nine samples of woods from Monterey-Nuevo Leon, 212 samples from the department of Vera Cruz, including 44 which are used for cabinet-work, and the rest chiefly for ship-building and carpentry, and 23 from Jalapa. The names of most of them convey no information. "*Tarai wood*" and "*White Equimite*" and "*Huaco*" afford no clue to the trees of which these woods are samples; and this defective nomenclature is the more to be regretted as we are assured that the island of Carmen, near Yucatan, exports wood to the amount of two millions of francs yearly, and that mahogany and cedar (Cedrela? or Juniperus?) grow there abundantly. *Dye-woods* are also sent from Vera Cruz. Bois d'Aloes, marked "*Lignaloe, Fagara lignaloë.*" This extremely fragrant wood is the *Bois de Citron du Mexique* of Guibourt, *Hist. des Drogues*, iii. 491, and quite distinct from the *Lignum Aloes* of pharmacy (Hanbury). Essential oil of ditto. Logwood and Brazil-wood are appellations familiar to us; they come chiefly from Yucatan.

its woods

barks;

Among the more miscellaneous articles are *Mexican Balm* (from Nepeta citriodora), *Saint Ignatius' Beans* (a powerful poison), medicinal *Barks* of *wild Cinnamon*, of *Copalche* (Quinquina), *Gum Elastic* and *Copal*, *Liquidambar* and other *Resins*, all bearing only the native names; the *Roots* of *Sarsa-*

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parilla, Jalap, Turmeric, Madder, Ginger and *Aromatic Aristolochia*, the root and fecula of *Convolvulus Michoacan*, and the root of *Pipitzohoac* (Eupatorium sessilifolium*); the *Flowers* of the *Mexican Aristolochia*, of *Dorstenia Contrayerva*, of *Commelina tuberosa*, and of a kind of *Chamomile*, called in Mexico *Astrogale* (all these flowers are reputed to have medicinal properties); the *Fruits* of the *Sago-Palm*, *Vanilla* and *Cassia*, the seeds of *Dolichos pinguis*, called *Pica-pica* &c. On the specimens of *Copal* (Copal blanco) Mr. Hanbury

resins;

remarks (*Pharmaceut. Journal*, vol. xv., p. 342,) that this resin has appeared in English commerce under the name of *Mexican* or *Vera Cruz Elemi;* it is the Tacamaque jaune huileuse of M. Guibourt's Histoire des Drogues, probably the produce of the Elaphrium elemiferum of Royle. Of the two specimens of *Résine de Liquidamber* (Liquidambar styraciflua) one is pale yellowish-brown and nearly transparent (it is obtained by incision of the trunk?), the other

and medicinal herbs.

grey and opaque (procured by boiling the young branches in water?), both are from the department of Vera Cruz:—of the *Contra-yerba root*, which is here as thick as the little finger, and is, perhaps, the produce of Psoralea pentaphylla, L., one of the Leguminosæ, described by some authors as *Contrayerva nova* v. *alba*, or *Mexican Contrayerva* root.

In this Class a Bronze Medal was awarded to the Mexican Government.

Guatemala.

XIV.—GUATEMALA.

(Commissioners: Le General Garcia Granados, and Emile Fournier.)

Guatemala collection: very trifling, containing only a few pharmaceutical articles.

This region, so rich in vegetable products, has afforded and contributed only one small case, affording nothing in our department save a few specimens of Materia Medica, mostly unknown in Europe, but enough to show what might have been done had there been the will to do it. The native or Spanish names alone are attached to the samples. Mr. Hanbury

* This plant has nothing to do with *Eupatorium sessilifolium*, which is a native of the United States; specimens in my possession prove this plant to be Acourtia rigida, *De Cand.* A chrystallized acid, of which there are samples accompanying the *Pipitzohoac* root, is extracted from the root. Powerful drastic and other properties belong to this acid, the smell resembles Valerian, and the taste is very acrid. It is insoluble in water, whether cold or warm, and is only dissolved by alcohol and ether. Combined with potash and with oxydes of iron and other metals, it dyes woollen, silk, and cotton stuffs with various shades of violet and yellow.

The above particulars are extracted from the Catalogue. The sample in the Exhibition consisted of glittering powdery chrystals, resembling, to the naked eye, gold dust, and quite as rich in color.

(*Pharmaceut. Journal*, vol. xv., p. 343,) has noted as follows,— *Estoraque de Balsamo*, samples, a pale yellowish-brown bark in coarse fragments, having an agreeable smell like Styrax Calamita; *Copal*, an odorous resin (Icica, sp.?); *Sangre de Drago*, a red resin in small masses, produce of a *Croton*?; *Guaco*, a small root, somewhat like Senega (probably the produce of Mikania Guaco or an allied species, for such are celebrated in South America as sovereign remedies in case of snake-bites; *Racine de Sintule*, aromatic, (Cyperus?); *Piment*, espèce dite Cordoncillo, (Piper, sp.?); *Piment de Vera Cruz*; *Piment de Vera Paz*; *Quinquina de Escuintla*; *Quinquina de Chiquimula*; *Mapaguite*, a small, oleaginous, orange-coloured fruit; *Suvin*, black legumes, about three inches long, used in dying; *Thé febrifuge*; and *Suif végétal*, or vegetable tallow.

Honourable Mention in this Class awarded to the Republic.

XV.—THE REPUBLIC OF NEW GRANADA.

(Commissioner: M. J. de F. Martin.)

New Granada collection: a few drugs.

"Bois jaune et bois de Brésil; *Balsam of Tolu* of Carthagena; *Vegetable Waxes* from the provinces of Bogota and Carthagena; Indian articles made of woods and varnished by the Indians of Gasto; *Quinquina de Neiba*, and *Quinquina* des provinces de Popayan and Bogota." These, we presume, so mentioned in the Paris Catalogue Officiel, 2d. ed., are what Mr. Hanbury (*Pharmaceut. Journal*, vol. xv., p. 343,) indicates as "*Quinquina du Peñon de Pitayo*, *Quinina de Pandi* and *Quinquina de Fusagasuga*, which he says are all referrible to the Quinquina orangé de Mutis of Guibourt's Histoire des Drogues, the produce of Cinchona lancifolia, *Mutis*, (Cinchona Condaminea, var. δ. lancifolia of Weddell; and the Quinquina de Pitayo, Mr. Hanbury remarks, is rightly labelled." There are also five samples of Vanilla from the forests of New Grenada.

Honourable Mention in this Class is awarded to the Republic.

XVI.—REPUBLIC OF COSTA RICA.

(Commissioner: M. G. Lafond de Lurey.)

Dye-woods, *Caoutchouc*, and *Woods* for construction and other purposes. Honourable Mention awarded to M. R. Escalante in this class.

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XVII.—ARGENTINE CONFEDERATION (including PARAGUAY).

Argentine Confederation.

Samples of *Wood* of Corientes, Entre-Rios, and Paraguay, *Maioca meal* and *Maté* (or *Parayuay Tea*, Ilex Paraguayensis). Many good samples of various drugs and dyes, but without tangible names or even useful remarks.

In this Class a Bronze Medal was awarded to the Republic of Paraguay.

Brazil.

XVIII.—BRAZIL.

Brazil collection: interesting, but small; chiefly of drugs;

An interesting but small case, exhibiting a Block of the Wood, Scrapings, Fibre, Root, Seeds, Hat, Mats, Lace, and two sorts of Candles, all the produce of different parts of the *Copernicia*, or *Wax-Palm of Brazil:* such is the entire contribution which represented this extensive empire, so peculiarly rich in Vegetable Products.

Towards the close of the Exhibition appeared a small but interesting collection of vegetable products, "obtained during an exploration of the River Amazon," by a Brazilian gentleman we believe. Mr. Hanbury thus reports on the Drugs recognizable (for there is no catalogue and almost no information could be obtained): "*Sarsaparilla Abutua*, a root somewhat resembling Pareira brava, but yellow; *Simaruba Bark; Brazilian Clove Bark* (Dicypellium caryophyllatum, Nees); *Casca pretiosa* (Mespilodaphne pretiosa, Nees), *Coca leaves* (Erythroxylon Coca, Lam.); *Sassafras Nuts; Vanilla; Tonka* or *Tonquin bean;* Guarana paste (Paullinia sorbilis, Mart.); some *barks* of *Cascarilla &c.*" But what interested me most was a model representing the mode of extracting the *Caoutchouc* from Siphonia elastica, and of the oven where it is prepared by being smoked and coagulated with the burnt nuts of the Attalea excelsa, a palm of the country. A very interesting account of preparing Caoutchouc from Siphonia is given by Dr. Weddell in the Pharmaceutical Journal, vol. xv. p. 116, and a still more interesting one in the following page by Mr. Spruce, extracted from Hooker's Kew Garden Miscellany for July, 1855, p. 193.

the mode of preparing caoutchouc in Brazil.

St. Domingo.

XIX.—ST. DOMINGO.

St. Domingo collection: unnamed, though sent by Sir R. Schomburgk.

A very miscellaneous collection, sent by Sir Robt. Schomburgk, H.B. Majesty's Consul in that island, and unfortunately without names, except here and there some of the country. Samples of *Woods* are numerous, cut, and imperfectly polished; they rarely present any beauty of colour

or veining. *Pina de Tea*, a large section of a tree, 2½ feet in diameter, and the leaves and fruit probably of the same—(is it not Pinus occidentalis?); *Guaiacum*, *Lana del Aibol de Yayruno*, *Resin de Airime*, *Divi-Divi*, *Fibres* and *Lassos*, *Baskets* and *Mats* (coarse), *Bamboo*, *Fibres of* "*Anona*" (Ananas?) and *Banana*, "*Asperillo fino con su Estrella*," this article looks like a horse-collar, made of split palm-leaves, and is very neat. Several *Walking-canes*, and *Tobacco* in long rolls, complete the collection.

XX.—BAHAMAS.

Bahamas collection: a few woods and fibres.

This very limited collection was only exposed at a very late period, and in our Department it exhibited nothing but a few woods, viz., "*Ebony*," *Iron-wood*, *Yellow-wood*, *Brazil-wood*, *Mahogany*, and a few others, unnamed; *Fibre of Pine-apple leaf* (Bromelia, sp.?), Hat of *Pita Plant* (Agave Americana), a quantity of *Pita* fibre, very long and good; a number of *Sticks* or *Walking-canes*, and a bag of *Fibre* from the leaves of "Pinus Tæda. 100 lbs. of leaf will yield 70 lbs. of fibre, which can be prepared at 2*d*. per lb." Also, a stout cord from some Palm. (?)

In this Class Honourable Mention was awarded to Mrs. Robertson for the Pita hat and canes.

XXI.—UNITED STATES.

(Commissioners: M. Maunsell, R. Field.)

United States collection: disappointingly insignificant.

"On est cruellement désappointé," exclaims M. Tresca, "quand, arrivé au pavillon qui indique les galeries de l'Union, "on rencontre à peine quelques échantillons de coton, quel-"ques machines, et divers objets de caoutchouc." In truth, the first notice of objects exhibited in the "Catalogue Officiel" has nothing whatever under Class II. A Second, or Supplemental Catalogue, specifies, as exhibited by M. André, of San Francisco, California, 1. "Mémoire sur les coupes de *l'Acajou ;* échantillons et dessin de l'arbre à *Caoutchouc ;* mémoire sur l'extraction du *Caoutchouc; Caoutchouc naturel et pur ;*—and "*Plantes et sucs médicinaux* (of California?); but these entirely escaped our notice; 2. "Seeaux et cuves de cédre, exhibited by M. M. Storms, frères, of New York." If these form part of the "*Boisellerie Americaine*" exhibited in the Annexe under the agency of Mr. Chas. Fay, I may observe that the stall, of considerable extent and with numerous objects of general woods, deservedly attracted very great

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United States.

attention, from the beauty of the woods, the perfection of the workmanship, and above all, the cheapness of the articles, as announced in the distributed advertisement. It was with difficulty that any could be procured for the Museum of the Royal Gardens of Kew, for all were bespoken. The buckets (so called) *rayé*, that is, the staves alternately of *Cedar* (*Pencil Cedar*), Juniperus Virginiana, and *Fir* ("*Sapin*"), with hoops of brass, were elegant and substantial, and delightfully fragrant.

Bronze Medal awarded to Mr. T. Thompson by this Class, and Honourable Mention to Mr. Ant. André, for Memoirs relating to Vegetable Products, and to MM. Storms frères, for sceaux et cuves de Cédre (Juniperus Virginiana).

New Zealand.

XXII.—NEW ZEALAND.

New Zealand collection: only a few fibres of little value.

Unworthy of notice, quite unnamed; it contains only a few specimens of Woods, cut and polished, New Zealand Flax (Phormium tenax), and indifferent samples of Kauri Pine.

Since our inspection, the Commissaire requested us to examine "a great variety of Fibres, which had recently arrived." They are from the Baron de Thierry, and consist of only two kinds, viz., the *New Zealand Flax*, and *Ti* (Dracæna terminalis).

The former is, 1, "Prepared by steam, an invention of M. de Thierry." 2. "Process invented by M. de T., for material for paper-stuff," a substance for which M. de Thierry claims the reward of 1,000*l.* offered in "The Times" for such a discovery. 3. "Pasteboard (execrably bad and loose), made at a first attempt, and proving that papier-mâché can be manufactured from New Zealand Flax."

Also a Fibre (very strong, but coarse) and prepared by M. de Thierry, from *Ti* (Dracæna terminalis); the yellow is prepared with cold water, the white with hot.

Hawaii.

XXIII.—KINGDOM OF HAWAII.

Wood formerly employed by the natives for making their lances and war-clubs.

Sardinian States.

XXIV.—SARDINIAN STATES.

(Commissioners: M. le Comte Antoine Nomis de Pollone.)

Sardinian States collection: native woods, and some articles made of them.

This presents nothing in our department, except a respectable collection of well-prepared native Woods; and a noble block, (from J. B. Bottero, Turin,) partly polished, of Juniperus Sabina, a very fine and handsome wood prized for

cabinet-work, and said to possess medical properties and to be a vermifuge: the block is valued at 500 francs. Also a great number of articles, made apparently of Beech; they are beautifully variegated and stained of different colours "par immersion." (The Pharmaceutical Journal, v. 15. p. 519,) announces that a new branch of industry has lately been established in Sardinia, namely the production of Alcohol from the *Cactus* or *Indian Fig*, which grows wild, with remarkable luxuriance, in every part of the country. The fruit is sometimes used by the poor as food, but more generally for feeding pigs; its price is about 7*d.* a hundredweight.

XXV.—PONTIFICAL STATES.

(Commissioners: M. le Baron de Havelt.)

Pontifical States collection: specimens of woods, cones, hemp, &c.

About 30 small blocks or *sections* of *branches* of Trees, cut more or less smooth, and about as many slabs, polished. Besides these, among which there was nothing peculiar, I remarked fine *Cones* of *Pinus Pinea*, and stalks of *Hemp*, of astonishing length, probably 20 feet, and with a diameter of $\frac{3}{4}$ of an inch or more. Such hemp is considered to yield a very inferior fibre. Still more remarkable in size was a specimen of the lower part of a Hemp stem, 5 feet long, with a diameter of not less than 3 inches. It is almost woody and solid; at least the section near the root has that appearance.

XXVI.—GREECE.

(Commissioners: M. Spiridion Spiliotakis, M. Georges Zizinia, and M. Alexandre Jonidis).

Grecian collection: trifling.

This Kingdom exhibits a small Box of *Woods*, and other small samples, about 70 or 80 in number; for which a Bronze Medal is awarded to the Hellenic Government; also *Acorns* and *Gall-nuts* for *tanning* and *dyeing*, *Sumac* for the same, and *Carobs* (pods of Ceratonia Siliqua), which are food for horses and cattle.

XXVII.—OTTOMAN EMPIRE.

(Sent by his Excellency, Moustapha-Noury-Pacha, the Governor-General of the Province of Tripoli, Barbary.)

Ottoman Empire collection: trifling.

Leaves of "Melèze," called *ar-ar* (purgative). *Gall-nuts* (*Afss*) for dyeing skins. *Gall-nuts* (*lubda*) for dyeing silks. "*Geranium chandgoura* (dépuratif)." "*Soie végétale*," derived from an Apocyneous plant. *Root* of *Iris* (Florentina). *Gum-arabic*. *Purgative oil* of a *Terebinthaceous plant*. In this department, though we do not find them noticed in the Catalogue, is a considerable collection of native *Pharmaceutical Vegetable Products* of the Empire, presented by M. Della Sudda to the Ecole de Pharmacie at Paris.

A Bronze Medal was awarded to the Province of Tripoli.

Sir W. Hooker on Vegetable Products.

Egypt.

XXVIII.—EGYPT.

Troëne (Privet-berries, for colouring wine). *Doum Palm* (Hyphene Thebaica). *Matting* and *Basket*-work. *Sennaar Gum*, and a few other trifling objects.

Tunis.

XXIX.—KINGDOM OF TUNIS.

(Commissioner: M. le Chevalier Elias Mussali.)

Chiefly cultivated plants. Numerous varieties of *Dates Black Olives. Brou de Noix* and its bark (probably *Fustic*, for dye). *Henna*, in leaf. *Karoni*, a small composite Seed. *Wallnut* (Ecorce de Noyer) bark, called *souak. Basket-work*, and *Cooperage.*

Singapore, Borneo, &c.

XXX.—SINGAPORE, BORNEO, &c.

(Products of the Indian Archipelago, of the Malay Peninsula, of Cochin China, and Siam.) Under the above head, and under British Colonies apart from "India," we find a brief Catalogue of what entirely escaped our notice:—"*Woods* of *Penang* for *inlaying, Swallows'* (*edible*) *nests, Vegetable wax* and *paste* from Borneo. *Resins, mastics,* and *gums* from Sumatra, Borneo, and Siam. *Caoutchouc* and *Gutta-percha. Katian-nuts*, and *oil* of the same. *Garribi Mats* and *inlaid-work.*"

Mauritius.

XXXI.—MAURITIUS.

(Agents: Messrs. Aubin and Husson.)

Mauritius collection: less valuable than might be expected from an island possessing a Botanic Garden.

With the exception of neatly prepared but very small specimens of correctly named native *Woods*, prepared by Professor Bojer of the Royal College, Port Louis, *Cocoa-nut Wood*, a few *Woods of the Seychelles, Nuts* of the *Coco de Mer* (Lodoicea Sechellarum), good *Vanilla*, and *Illipé Oil* from Bassia butyracea, there is nothing of the smallest interest belonging to our Class, which is the more to be regretted and the less to be expected, inasmuch as there is a very old established Botanic Garden, kept at the public expense, formerly belonging to the French, and celebrated as the recipient of the rarest and most interesting tropical plants and fruits from the Malay Archipelago and the West Indies and Tropical Africa, which were thence distributed to all the East Indian possessions, both French and English,—while more than one very able and accomplished Botanist resides in the island.

XXXII.—TUSCANY.

If the samples of Woods sent from Tuscany to the Great Exhibition in London attracted notice, the present Collection is equally deserving of attention; especially as many of them are eminently adapted for Ship-building. The specimens in block, retaining the bark, with the inner surface cut and polished, are 69 in number, botanically named. Others, which are squared and smoothed, but not polished on all sides, bear numbers only. The former represent the forest-woods of the country (native and introduced), the latter the Naval Timber. Some of these appeared to be of excellent quality, very heavy: others were inferior, and seemed to possess no great durability. Among the Pines, Abies pectinata is reckoned particularly good. (A Tree of this species in Tuscany is ascertained to be 400 years old.)

Tuscan collection: its ship-building woods valuable;

M. Siemoni, the manager of the Grand Duke's private domains, in the province of Casentino, transmits samples of the forest-products under his charge; among them a horizontal section of Deal, upwards of 2 mètres in circumference, one of Beech 3½ mètres in circumference, a hollow cylinder of Elder more than 7 mètres in circumference, and squared beams of Carpinus Betulus, of remarkable length and thickness. The Ivy and Hawthorn also attain the size of timber in these woods, as shown by samples. There are also many articles made of the above kinds of wood, among them Tubs and Boxes; the latter are in nests, and though of simple workmanship and very cheap, they are remarkably neat and well finished. The fruits or cones of Pinus Pinea (the Stone Pine) are particularly large and fine. There are also Oil of Lentisk, Oil of kernels of the Pine, and Olive Oil, and Manna of good quality in drops, collected at Rocca Strada.

Large Trays, divided into compartments, contain many native wild Vegetable Products (as well as cultivated ones). I noticed dried *Lime flowers* for Tisane, *Birch* and *Elder flowers* for the same purpose, *Fruits* of *Juniper* and *Whortleberry* (Vaccinium Myrtillus) for colouring wine. There are also numerous *Oils and Essences.*

The most interesting part of the collection is the beautifully arranged series, exhibiting the progress of Straw-platting, as practised in Tuscany, from the delicate, slender Plants of Wheat, with small bearded ears, to the perfect and valuable Leghorn bonnet, or basket, &c.

beautiful samples of Leghorn plat;

The chief novelty in the Tuscan collection is a series of specimens illustrative of the production of Alcohol, Paper, and Card-board from the roots and stems and foliage of the *wild Asphodel* (Asphodelus ramosus). They are accompanied

and highly interesting specimens of alcohol and paper, obtained from the wild Asphodel;

Sir W. Hooker on Vegetable Products.

Tuscany.

by a pamphlet of 72 pages, giving a full history of the plants, by M. Pinondel de la Bertoche, with an account of a society which is forming in Tuscany for the manufacture of these articles on a large scale. Every one is familiar with the pretty, lively-looking white-flowered Asphodel of our gardens. In the South of Europe, and apparently on both sides of the basin of the Mediterranean, the plant is extremely abundant; though it has never, so far as I know, been turned to any account, except that in times of scarcity its acrid fasciculated roots, after much boiling, have been eaten by the poor. The present Collection displays, from the "Franco-Italian Society" established at Florence, for the distillation of the Asphodel, the following objects in connexion with the subject:—Well prepared specimens of the Plant, with roots, stems, leaves, flowers, and fruit from dry rocky places, and others from the marshes of Talamone and from the forest of Alberese, with a dissertation on the feasibility of growing the plant in the Pontine Marshes, and the Maremma. Bottles of Alcohol extracted from the Asphodel; specimens of the residuum of the roots after being twice distilled; paper stuff from the stalks and leaves of Asphodel, card-paper, cards, paper, and writing-papers, of various qualities, manufactured from the same, and mixed in various proportions with rags and common paper-stuff.

M. de la Bertoche, in the above noticed pamphlet, asserts that Asphodel roots contain upwards of 27 per cent. of alcoholic principle, or more than double the quantity which resides in the root of Beet. The stalks and leaves contain a remarkably tenacious fibre, fine, strong, and flexible.

The distillation of Asphodel root has been already pursued, and with considerable success, in Algeria; but the immense abundance of the plant in Tuscany, where it has hitherto been considered only a pernicious and most ineradicable weed, points to the advantage of endeavouring to turn it to account. The fasciculated roots, after cleansing and crushing, are mixed with water, and the fluid is exposed to heat, so as to facilitate fermentation. The Alcohol, which it yields, is pure and colourless, perfectly transparent, and has the smell of Alcohol itself. It contains neither acid, salt, nor oily matter: it burns without leaving any residue, and the flame is remarkably bright. So much for the spirit which is extracted from it. But, at the present time, when material for paper seems likely to fail, a most important succedaneum is afforded by the remains of the Asphodel. It is well known that the price of rags is now doubled, and that many substitutes for this material have been suggested. Straw, nettle-fibre, sawdust, cotton, the leaves of Maize and Banana, and

various other substances, have been tried with more or less success; but if the desired article can be procured from a substance which has already served a valuable purpose and is comparatively only refuse and dross, a double end is gained. And it is undeniable that the residuum of the Asphodel roots, after distillation, together with the other parts of the plant, are eminently adapted to this object. The expense of adding the foliage and stalks is no more than that of mowing them. Three processes are necessary,—the separation of the useful portions,—the bleaching,—and the reducing the substances into a homogeneous and tenacious pulp. The first is better effected by crushing than by grinding, as the latter mode is apt to destroy the fibre. The second operation involves most difficulty, as the root is covered with a skin, which contains a tanning principle; and it is necessary, unless the expensive method of hand-peeling the root be adopted, to expose the substance to air and light, aided by immersion in diluted chlorine, which brings the substance to a very pale brown tint, which is not objectionable for many sorts of paper. For the third process, that of reducing the whole mass to a smooth and tenacious paste, the paper-manufacturers must supply the details: they have indeed already effected the object, and produced beautiful drawing-paper, paste-board, card-paper, and mill-boards of various sorts, all eminently *fine and glossy*, and possessing every recommendation, save perfect whiteness.

The gum, which abounds in the Asphodel, is a highly advantageous ingredient: it gives gloss to card-board, and prevents writing-paper from becoming absorbent. The stoutest cartridge-paper, which is made from this plant, is found to bend without breaking, and is not apt to tear.

Corsica, Spain, Algeria, Portugal, all have hastened to follow the example of Tuscany, and to seek to derive advantage from the Asphodel, either as yielding Alcohol or Paper-stuff, or both. If even the enormous tracts which are covered with Asphodel should in time be exhausted, the culture of of the plant is by no means difficult. It has been the subject of experiment in the Royal Botanic Garden at Florence, where it increased by tubercles and runners only too fast; for the very moving of the soil to eradicate the plant, causes it to spread and multiply four or five fold. The manager of the Grand Duke's domain at Alberese offered, a few years ago, 40,000 francs for the extirpation of the Asphodel in a comparatively limited territory, and no person was found to undertake the next to impossible task.

The noblest specimens are seen in the forests of the Apennines, and on the seashore. The plant grows abun-

Sir W. Hooker on Vegetable Produbts.

Tuscany.

its culture likely to prove a great boon.

dantly in meadow-land also, and is not rejected by sheep, nor injured by their tread.

To sum up the matter, the Asphodel produces Alcohol and Paper, at a much cheaper rate than any other material which has yet been tested; and there is good reason to hope that it may yet prove a providential benefit to many sterile and unproductive districts. Practical and scientific men are earnestly invited by M. Bertoche to turn their attention to the subject, and to carry out a series of experiments, which shall establish the value of the discoveries which he so ardently promulgates.

In this Class a Silver Medal was awarded to M. Siemoni for forest products.

Spain.

XXXIII.—SPAIN (including CUBA).

Spanish collection: its forestal production interesting, but ill-named.

Though due notice was given by the Secretary of Class II. of our visit to the Spanish Collection, we were not favoured with the assistance of the Commissaire, which would have been eminently useful in the absence of any Catalogue, save a bare List of the Woods and their Products. The Collection is, however, a remarkable and interesting one, which reflects much credit on those who formed it. Many of the objects are unnamed; others have only Spanish names. The Woods are in general scientifically named. The Catalogue is entitled "An Enumeration of the Natural, Industrial, and Artistic Productions, displayed in the Spanish Section of the Universal Exposition of 1855." This List corresponds with the numerous sections of Woods which, probably, collectively represent the forestal resources of Spain Proper, independent of its Colonies. They are alphabetically arranged, and consist of 2 species of *Abies*, of *Acer* 8 (including 2 from North America,) 1 *Æsculus*, 1 *Ailanthus*, 1 *Alnus*, 1 *Amygdalus*, 1 *Arbutus*, 1 *Berberis*, 1 *Betula*, 1 *Broussonetia*, 1 *Buxus*, 1 *Calluna*, 1 *Carpinus*, 1 *Castanea*, 1 *Catalpa*, 2 *Celtis*, 5 *Cerasus*, 1 *Cercis*, 2 *Cistus*, 2 *Citrus*, 2 *Cornus*, 1 *Coronilla*, 1 *Corylus*, 9 *Cratægus*, 3 *Cupressus*, 1 *Cydonia*, 2 *Cytisus*, 2 *Diospyros*, 1 *Eleagnus*, 4 *Erica*, 1 *Euonymus*, 1 *Fagus*, 1 *Ficus*, 5 *Fraxinus*, 3 *Genista*, 2 *Gleditschia*, 1 *Gymnocladus*, 1 *Hedera*, 1 *Hibiscus*, 1 *Ilex*, 3 *Juglans*, 5 *Juniperus*, 1 *Laurus*, 1 *Ligustrum*, 1 *Lonicera*, 1 *Melia*, 1 *Mespilus*, 3 *Morus*, 1 *Myrtus*, 1 *Nerium*, 1 *Olea*, 2 *Pavia*, 1 *Persica*, 2 *Phillyrea*, 9 *Pinus* (including *Cedar*), 3 *Pistacia*, 2 *Platanus*, 9 *Populus*, 2 *Prunus*, 1 *Punica*, 6 *Pyrus*, 16 *Quercus*, 2 *Rhamnus*, 1 *Rhus*, 4 *Robinia*, 1 *Rosa*, 1 *Rosmarinus*, 7 *Salix*, 1 *Sambucus*, 1 *Sophora*, 1 *Spiræa*, 1 *Staphylea*, 1 *Syringa*, 1 *Tama-*

Woods.

rix, 1 *Taxodium*, 1 *Taxus*, 1 *Tecoma*, 1 *Thuja*, 2 *Tilia*, 1 *Ulex*, 2 *Ulmus*, 3 *Viburnum*, 1 *Vitex*, 1 *Zizyphus* ;— 186 species in all, named in Latin and Spanish, but accompanied with no remarks.

Of *Charcoals* there are 44, with Botanical, French, and Spanish names. There are also *Charbonnailles* for Crayons, prepared from Cistus ladaniferus, and from the Cones of Pinus maritima and P. Pinea, and from the acorns of 3 Oaks, (Quercus Ilex, pubescens, and Robur). The *Resins* from the different Pines are numerous, but except the *Spanish Pine*, the *Aleppo Pine*, *Turpentine*, *Juniper*, and *Sandarac*, their names are Spanish and local. There is *Birdlime* from the *Holly* and *Mistletoe*, and a substance called Galipot, manufactured by Meceta & Co. Charcoal.

From the *Ecole Forestière* of Villaviciosa is a collection of *Forest Produce*, *Charcoal*, *Charbonnailles* (for crayon drawing), *Wood-ashes*, *Resins*, *Barks*, *Spartes*, together with Tools, mallets, and measures employed in woodman's work.

Of *Espartos* (*fibre of* Lygeum Spartum), there are noble samples, both raw and prepared, consisting of Bundles of rope of various sizes, from string for nets, to cables for ships of large size, and applicable to different purposes, hauling vessels into port, boarding ships, &c. *Barks for Tanning* are those of the *Alder*, of the *Aleppo*, *Spanish*, *Corsican*, *Bordeaux*, and *Stone Pines*, of the *Ilex*, *Cork*, and 4 other *Oaks*, and 3 kinds of *Willow*. Fibres.

In *Cork* there are most beautiful specimens of carving, as Boxes and Inkstands, Cork soles, Stoppers for bottles of all sizes, and slices of cork both raw and prepared.

Under the title of "*Plants*" are well-preserved branches, with the *Acorns* and sometimes *Galls* of Quercus avellanæformis, 16 varieties of Quercus Ballota (the oak with edible acorns), 3 branches of the *Spanish Oak*, 3 of the *Lusitanian Oak*, and as many of the *Cork Oak* and *Ilex* or *Evergreen Oak*.

Under the head of *Forests of Costa Firma* are 105 samples of woods, small and polished, all placed in one large frame, and with the local names only. Miscellaneous products.

Among numerous Vegetable Products (chiefly cultivated) are dried specimens of *Salsola* (species of), with *Soda* and *Barilla* prepared therefrom (at Alicant). Barcelona *Nuts*, remarkably large, *Earth-nuts* (the tubers of *Arachis hypogæa*), *Liquorice*, rough and refined, liquid and in lump. Seeds of *Canna Indica* (for what use?) 2 small *Agarics*, dried on string, (Agaricus albellus and A. aromaticus). *Carob fruits*. *Onjones* (dried Peaches). Roots of *Alkanet* (Anchusa tinctoria), and a few *Drugs* and *Dyestuffs*, wild and cultivated.

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Spain.

Planks of *Date Palm* (a very light and soft wood; for what use?)

"*Tesca* (Amadou);" under this name is a fibrous cottony substance, some white and some yellow, but of what material it was impossible to determine. Fruits of Capparis spinosa (*Capers*) from Cordova, in pickle. Reseda lutea (*Dyers' Woad*). Dried leaves and stalks of *Sage* for making Tisane. Cones and seeds, very large and good, of the *Stone Pine* (Pinus Pinea).

To sum up the Spanish collection, it may be pronounced as distinguished by the great variety and value of its forest productions.

Colonies of Spain: send little except tobacco.

The Spanish Possessions or Colonies are miserably represented. In Class II. *PORTO RICO* only exhibits a few unnamed *indigenous woods*, samples of *Gum Elemi*, and *fibre* of *Banana*, "*Maguey*," and "*Ananas*." *CUBA* ranks a little higher, but its productions here exhibited are almost exclusively manufactured articles, and, as might be expected, chiefly Tobaccos and Cigars. I searched in vain for specimens or information relating to the little known *Pine* which gives name to the "Isla di Pinos," or the celebrated wood called *Sabicu*. The origin of this wood is still a vexed question; Don Ramon de Sagra attributing it to the *Acacia formosa* of Humboldt and Kunth, Mr. Bentham to a new species of *Lysiloma*, viz., *L. Sabicu*, Benth. "Son bois," says M. de Sagra, "est dur et d'un usage très repandu; on en fait des soulives ou des planchers: on l'emploie également dans certains ouvrages de charronage, par exemple dans la construction des charettes." This has been a great article of trade with the Cubanites. No less so is a very beautiful substance familiar to us under the name of *Cuba-bast*, and long known as the material used for tying up the Havanna Cigars into bundles. It is a kind of Lace-bark (and of the same nature, being the inner layers of the bark of a tree), almost as delicate, and even more silky than the well-known Lace-bark of Jamaica (Lagetta lintearia). Of late years it would seem the merchants of Cuba can turn it to better account. It has been found by gardeners and nurserymen equally fitted for tying up plants, &c. as the Lime-tree bark or *bast* from Russia, and has been largely substituted for it, and it is extensively imported in bundles, and may be often seen at the shop windows of nurserymen and seedsmen in London. All these three objects, information respecting which the Spaniards systematically withhold, have been recently inquired into by a scientific friend of mine, a casual visitor to Cuba, Henry Christy, Esq. Branches with Cones of the *Pine* have been communicated

Information afforded by Mr. H. Christy, respecting somecurious Cuban articles, not included in the collection.

by him during the present year (April 1856), and prove it to be identical with, or very closely allied to the North American *Pinus resinosa*, Soland. of which Cuba may be considered the southern limit, as Lake St. John, Canada, is the northern. Its leaves are longer than those of the continental P. resinosa, but in other respects they, as well as the cones, seem to be identical. I possess specimens from New Orleans, so that this species has a most extensive range. Specimens of *Sabicu*, sent at the same time, prove that Mr. Bentham's views, expressed in the Kew Garden Miscellany, vol. 5, p. 236, are correct (*it is Lysiloma Sabicu*;) and specimens and seed-vessels from which young plants are raised at Kew, show the *Cuba Bast* to be a Malvaceous plant, the *Paritium elatum*, Rich. (Hibiscus elatus, *Sw.*), a tree scarcely to be distinguished from the P. tiliaceum, St. Hil.

In this Class a Silver medal was awarded to the Ecole Forestière de Villaviciosa for forest products, charcoal, and charcoal for drawing, woods, ashes, resins, barks, esparto, &c. &c., and a bronze medal to M. Carere and to M. F. Fonorella for corks.

XXXIV.—PORTUGAL AND ITS COLONIES.

Portuguese collection: rather extensive.

As a whole, this is a rather extensive collection, though deficient in correct and scientific nomenclature, as well as in arrangement. There is, however, a catalogue which assists in pointing attention to some of the products, such as—

Pine Wood, Pitch, Tar, and Spirits of Turpentine, sent from the General Administration of Forests. *Resin* from the *Plum-tree, Orchill.*

Woods.

A very good collection of *Portuguese Woods*, fairly numerous, but ill-named; 18 are cut into long pieces and smoothed; among them are fine specimens of the *Orange*, the *Ilex* (and its bark for tanning). *Fig, Stone-Pine, Sea-side Pine*, and *Cedar* (very good). *Cork*, in large sheets and cut. *Amadou*, &c.

Acorns for tanning and *Myrile leaves* for the same purpose. *Resin* from the *Cedar.*

Woods employed for building purposes. Timber from the *Black Oak, Wallnut*, and *Carob tree.*

Textile Barks, Rushes and *Reeds* for mats. *Lime-Flowers. Baskets*, and *Bags* of *Agave. Palm leaves*, and *Sabots* of the same.

Woods of Madeira, unnamed and small, but some very beautiful, and numerous small articles of marqueterie.

Sir W. Hooker on Vegetable Products.

Portugal and its Colonies.

Fibres.

"*Tacula*" (?) wood, from Angola. "Orseille" (?) *Copal Resin* from Angola, Benguela, and from Ambrisete and Guissama. *Lichens.* *Dragon's Blood* and *Elemi* from the same. *Baskets* and *Mats* made *of* Masseta (the Reed-mace, Typha) very large. *Vegetable Fat* from Mafura. *Manna* from Cape Delgrado. Purgative powder. *Mats* from Mozambique, (made of Raphis vinifera). *Wood* of Teca and of Sico. Coffee from wild plants at Solar and Timor. *Fibre*, marked from "Sanseviera Angolensis" (which is a *MS.* name of Dr. Welwitsch for a remarkable new species of *Sanseviera*, with long stout terete leaves: it is now in cultivation at Kew). The cordage and rope made of this plant appear to the eye of excellent quality, whatever experience may prove them to be. The *Sansevieras* are remarkable, in general, for the strength and tenacity of their fibre, so that one kind is called "Bowstring Hemp." "*Jonca*" is the fibrous leaf of Cyperus longus (?), used in making mats and baskets. *Brooms* of Cocoa-nut fibre. Various other Samples of *Woods* and different products, bearing no name, and therefore conveying no information.

In this Class a Bronze Medal was awarded to the "Arsenal de la Marine à Lisbonne" for Woods, &c. of Portugal: a Bronze Medal to Dr. Barral for a collection of Woods of Madeira; and to the Conseil des Colonies à Lisbonne, for Orchil.

Austria.

XXXV.—AUSTRIA.

Austrian collection: eminently rich in woods; valuable information afforded respecting them;

In this extensive and valuable collection, the *Woods* were the portion which chiefly fell to the inspection of Class II. And here the task was facilitated by the guidance of a most intelligent and enlightened gentleman, M. Kreuter,* than whom it were difficult to point out any individual equally well informed upon all matters connected with Forestry, whether as regards the natural state (so abundant in the Austrian Dominions), or the planting of new Forests, or the nature and value of Woods. Austria possesses, indeed, a vast amount of Timber, which her Government wisely seeks to turn to the most profitable account. Unfortunately, the best kinds are yielded by the most mountainous districts, from

* On his return to Vienna, in February 1856, M. Kreuter published, in the "Allgemeine Land-und Forstwirthshaftliche Zeitung," an interesting but brief notice of the "Forest Economy" of the Great Paris Exhibition, specially alluding to the Austrian Department, from which some of the following information is obtained. The "Catalogue spécial des Envois d' Autriche," is little more than a List of Contributors' names, with the exception of a Statistical Preface.

whence the difficulty and cost of removal are very great; and it is an acknowledged fact that the same sort or species of Tree, whether Oak or Pine, which affords most admirable wood in the poor soil of the elevated mountains, is nearly valueless, except for firing, at the foot of the hills, and in the accessible plains, where there is a richer soil, washed down from the high ground, and a far warmer climate.

Many of the samples of Timber in this Collection are corroborative of this assertion.

A box of *Seedling Specimens*, from Bohemia, two years old, illustrates the principal *Trees* cultivated in Bohemia: they are *Pinus sylvestris* and *Picea*, *Larix*, *Fraxinus excelsior*, and *Quercus Robur*. They are grown on a poor soil, and sown in ridges, (the ridges being made artificially to give them a greater depth of earth;) and the second year they are planted in the forests.

Samples of *Oak* and *Pine* are particularly fine; they are in longitudinal and transverse section (with the bark on), and both rough and smoothed; some were nearly 6 feet in diameter, and of most perfect growth. fine specimens.

A section of *Pinus Pinea*, from the forests of Silesia, at an elevation of 4,500 feet, and in very poor soil, has 220 rings.

Larch from Galitzia, grown at a great elevation on the mountains, has 280 rings, and is only 2 feet in diameter; the wood is very compact and valuable. The same tree, at the foot of the mountains, with only 250 rings, is $3\frac{1}{2}$ feet in diameter and the wood is worthless. The former is so excellent in quality that it repays the enormous expense of cutting into planks on the spot and sending them for 20 miles, on men's backs, to a cheaper line of conveyance on level ground; these planks are much sought for as sounding-boards of musical instruments in England. Noble specimens are exhibited, some in block, from 20 to 30 feet long: one unrivalled sample had 430 concentric rings in a diameter of only 14 inches. Whereas the common size of a section, with that number of rings, is thrice as big.

Besides various native woods, the collection includes the numerous implements used by foresters, some of which well merit attention, especially two kinds of dibbles, one for planting out seedlings, (taken up in the second year,) and the other for planting those of 4—6 years old.

*Knoppern** is the name given to a peculiar kind of Gall Galls of acorns, called Knoppern, the best for

* This Gall was pronounced by some naturalists to be quite a new species, and hitherto only known to be produced in the forest of Hungary. The following account of it is given in a hand-bill, which was distributed by the exhibitor:—

"The *Knoppern* is simply an excrescence of the acorn; it is abundant in Hungary, and it fetches a considerable sum. It is by no means an universal

Sir W. Hooker on Vegetable Products.

Austria.

which affects the acorn of the Oak, and forms large, crest-like, thick and spongy excrescences. The Insect which causes them abounds in some years more than others, and an abundant harvest of *Knoppern* yields an immense revenue to the proprietor of the forest which is thus affected. They are stated to be largely purchased in Britain for tanning leather. The commoner globose Galls (Cynips Quercus) are of no value. It would be very desirable to determine the exact insect which causes the *Knoppern*; specimens of the *Oaks* producing them show the trees to be the Quercus pedunculata and Q. pubescens.

Amadou is amply exhibited; but the sale of this substance has much declined since the invention of Lucifers. Old decayed Holly-wood forms good Amadou.

Medicinal plants, &c.

There is a rather considerable collection of *cultivated Seeds*, &c., and of *medicinal Plants;* the most interesting is the

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production; nor is it always to be found on the identical trees which generally yield it. Not every acorn-bearing Oak has *Knoppern* growing on it; it is confined to the species or variety, called *Quercus stagnosa*, which inhabits valleys and damp marshy places. And even on this tree, it only appears when the nights are warm and rainy, and towards the end of July and beginning of August; it is then that the outer coat of the acorn is softened and punctured by the Insect, and the heat of the sun draws out the sap, which forms this curious excrescence. The hotter the weather is, the larger are the *Knoppern*, and the more easily do they drop to the ground, where they are regularly gathered up with the least possible delay, as the damp earth would spoil their quality and colour; for which reason the *Knoppern* should be dried for five or six days in the sun, and then turned over many times a day for some weeks, to prevent their becoming mouldy. Thus dried, they sell for various purposes, and chiefly for tanning leather. In a favourable season, these galls are so abundant, that a single large *Marsh Oak* will produce as many as fetch 250 francs on an average; but the price varies prodigiously, from 10 francs to 40 francs the kilogramme, according as it is a good or bad season for them. They are chiefly exported to England, Germany, and other parts of Austria; and the trade is now in the hands of the Jews."

Since my return to England I learn from my excellent friend, Mr. Hanbury, the following additional particulars:—

"These galls are not unknown in commerce; the best account of them to which I have access at this moment is in Martiny's Encyklopädie (1847,) a German book. He says they are commonly called (by *pharmaceutists*, I presume,) *Gallæ quercûs calycis*, and that the insect occasioning them is the *Cynips quercûs calycis* of Entomologists. Further, that these galls are largely produced in Hungary, Moravia, Sclavonia, Styria, &c., and that the towns of Pesth, Oldenburg, and Trieste, are the places where the trade in them is chiefly carried on. The Estates of Prince Esterhazy, in Hungary, are said to produce a large supply of this gall.

For representations of *Knoppern*, Martiny quotes Zenker—*Merkantil Waarenk*, Bd. iii., Taf. 49, fig. 8. 9., and Hayne—*Arzneneigewächse*, Bd. xii. Taf. 47, fig. 6. 7., Guibourt in his *Hist. des Drog.* t. ii. p. 280. figures the gall in question as *Gallon de Hongrie* ou *du Piémont*. Perhaps even his *Galle corniculée*, fig. 139, is the same thing.

Pereira quotes him in his *Elements* of *Materia Medica*, vol. ii. p. 1226. "In most of the samples of the galls I procured, the gall has completely invested the acorn, which lies concealed inside. Its origin seems to be invariably from the cup of the acorn.

root, raw and prepared, of *Rhubarb*, Rheum Emodi (R. australe of Don.)

Teasels for dressing cloth are of excellent quality; and no machinery has yet been invented which adequately replaces them. They are extensively cultivated in Hungary, and also collected from the wild plant, and sent by way of Prague to England, &c.

Of *Bast*, from Tilia Europæa, there are fine specimens: the raw material and some even made into artificial flowers. It has been an article of great consumption for out-door Mats, and for the gardener's use in tying up plants; but, for the latter purpose, it was for a time superseded by *Cuba Bast.*

Biscuits made from the core of maize.

A small box contains, 1. The *core*, or *receptacles* of the grains of the ears of Indian Corn or Maize, which, in time of scarcity, have been advantageously converted into nourishing bread or biscuit. 2. The core broken down. 3. The same still more pulverized. 4, 5, 6, 7. The flour, into which the core is converted, in various degrees of fineness (the seeds having been removed). 8. Flour from the seeds or grains, showing the difference.—A basket of the biscuits is placed beside this box.

Austrian forests; their value.

The Statistical Preface to the Austrian Catalogue asserts that an entire third of that Empire is clothed with forests, which annually furnish 17 millions of "cubic cords" of wood, of all descriptions. In some provinces, the country is almost wholly covered with trees: in others, the proportion is small. This circumstance, combined with the different prices of labour, the irregularity of demand (for steam-engines, railways, steam-ships, &c.) cause an extreme disparity in the value of wood in various parts of the Austrian Empire, so that while timber is extensively exported, it is also largely imported from Switzerland and Piedmont. The average value of the yearly exportation of wood, for building and fuel, in blocks, logs, beams, rafters, planks, laths, &c. amounted in 1852 to upwards of 27 millions of francs (more than a million of pounds sterling).

Charcoal.

Charcoal, especially for foundries, is also an important branch of industry, and gives employment to upwards of 5,000 workpeople. It is however, but little exported. Entire districts, especially in the mountain vallies of Bohemia and Tyrol, are inhabited by workers in *fine wood, inlaid floors, marquetery, &c.* Cabinet-work is chiefly pursued at Vienna, Prague, and Milan, and furniture was thence exported, in 1852, to the value of a million and a half of francs. Fancy articles and wood turnery are almost confined to Milan, where the name of *intarslatura* has been given to this kind of industry for many centuries.

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Austria.

Carriages and *Musical instruments*, especially *Pianofortes*, must by no means be overlooked among the Austrian productions which make a demand on the forests; the latter are much esteemed, and in Vienna alone about 3,000 are made every year. Ship-building is conducted principally at Trieste, Venice, and Fiume, with a steadily increasing activity. Reckoning the hulls and masts and spars of a ship to be strictly *articles of wooden manufacture*, the annual value of ship-building is estimated at between two and three millions of francs, and that of repairs at a quarter of a million. Boats for river navigation, to be used on the Danube, Elbe, &c., and steam-vessels must also be added.

Articles of wooden manufacture, as carriages and musical instruments.

Its woods, &c.

M. Kreuter gives his testimony to the importance of the Austrian Forests in very striking words. He says, "Shall we be told that it is needless to exhibit samples of Oak, Elm, Fir, and Larch, because everybody knows these woods? True; but still it was these very specimens which attracted the greatest attention, from their strikingly superior perfection of growth, and their admirable quality, excelling even the specimens from British North America. Besides, now is the time when Timber for ship-building is in unusual request; and it was universally allowed that the Austrian Oak is superior to all others in dimensions and quality. One section, from an oak 64 years old, measured 3 feet in diameter, and elicited the admiration of ship-builders and engineers of all nations."

Austrian Fir is equally valuable as Austrian Oak; no wood is so good for the sounding-boards of musical instruments.

The establishment of railroads causes an immense demand for timber; each sleeper measures 3 cubic feet, and one mile of single rails requires 8,000 sleepers, which lasting on an average 5 years, gives a yearly demand for 1,600 sleepers, or 160,000 sleepers for every hundred miles. Austria is always laying down new railways. The ingenious process of Dr. Boucherie (noticed under French Collection, next page), who impregnates timber with metallic oxydes, thus rendering almost incorruptible the softer woods of *Birch*, *Beech*, *Maple*, *&c.*, which could not otherwise be used underground, will greatly increase the supply of sleepers, besides saving the more valuable trees.

Ingenious machinery, for manufacturing barrels, by which half the cost is spared, by making half the quantity of wood serve the purpose, is also exhibited.

Government is taking measures to secure the national orests, those sources of the empire's wealth.

In conclusion, it is much to be desired that Austrian cultivators should introduce the Conifers of the East Indies and North America.

A Bronze Medal in this Class was awarded to the Domaine impérial de Brandeis, and to Count de Zamryski for Woods, and Honourable Mention to Messrs. Daply and De Kubiyi for Knoppern, and to Count d'Elz.

XXXVI.—FRANCE.

In the Department of Class II., France (exclusive of its Colonies), exhibits but few and miscellaneous objects:

French collection: its contributions to Class II. not numerous;

Woods of Corsica.—20–30 large Planks, in the Agricultural Department, sent by the Administration of Forests in Corsica, to whom "Honourable Mention" has been awarded. A duplicate collection has been presented by the French Government to the Museum of the Royal Gardens at Kew.

M. Boucherie showed his process for impregnating truncheons of wood with sulphate of copper, the liquid, in less than two minutes, oozing out at both extremities. M. Boucherie regrets that the English do not patronize his invention, which is extensively employed in France for the sleepers, &c. of railways. This neglect on the part of our country was the less to be expected, because the "Jury Report" upon this subject, on the occasion of the Great Exhibition of 1851 (p. 153), was eminently favourable and complimentary, and a Prize Medal was awarded for the discovery. So fully indeed is the process described there that I shall only give the concluding remarks of a "Report on the results of Dr. Boucherie's process for preparing woods," in a pamphlet, circulated at the Paris Exhibition. "We conclude, from what has been stated, that Dr. Boucherie has invented very simple and practical processes for permeating the interior of portions of white wood of all dimensions, with prepared fluids, which promote their preservation. That this injection, even with substances most favourable to penetration, is most speedily performed when a tree is fullest of watery sap, and is most recently felled. That certain descriptions of wood are utterly impenetrable by these solvents. That, among the various fluids tried by M. Boucherie, the sulphate of copper dissolved in the proportion of at least 1 kil. 50 (3 lbs. 6 oz.) in the hectolitre (42½ cubic feet) of water is the only one which has maintained in perfect preservation for seven years the pieces of beech and of hornbeam submitted to experiment. These were permeated by sulphate of copper in the proportion of 5 to 6 kil. (11–12 lbs.) to the stère (35½ cubic feet). That white woods, thus imbued and laid in the ground for sleepers of railways, last longer than those of oak placed in the same situations. That it, therefore, follows that it would be

but M. Boucherie's process for copperizing wood highly important.

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France.

desirable in future to use white woods, similarly prepared with sulphate of copper, whenever they can be employed in the above-mentioned situations."—In France this process has been most favourably received. In the forest of Compiegne M. Boucherie has establishments for felling and preparing the timber for the Government railroads on a very large scale, and a "Grande Médaille d'Honneur" has been awarded to him by the Jury of 1855.

Agricultural and useful plants, shown by M. Vilmorin.

The noble and very extensive *Agricultural Collection* of MM. Vilmorin, Andrieux, and Co., contains several objects that might be claimed by our Section, viz., an extensive collection of the *Seeds of useful Plants, native* and cultivated; specimens of *Textile Plants;* others, which are used for dyeing and for economical purposes; *Woods*, with their applications, especially the different kinds that can be advantageously employed for hoops in cooperage: *Cones of Pines, Oils, Spirits, Primitive Substances*, with the plants from which they are derived. A highly valuable set of *Drawings*, first-rate in execution, of the species and varieties of plants cultivated in France, contains many which are indigenous to that country.

M. Chambrelent's success in planting and fertilizing the Landes, near Bayonne.

M. Chambrelent, of Bourdeaux, exhibits samples of young trees, *Oaks* and *Pines*, sown in the Landes or sandy plains of the Gironde in 1852, and cut in 1854, after the shoot of that year, and consequently presenting 4 rings, or circles, in the transverse section. These specimens attracted great attention, being remarkable for their size taken in connexion with the well-established fact of their age (youth, rather,) and from the circumstance of their being reared in a district and upon a soil notorious for sterility. The Oak is a common oak (but whether Quercus pedunculata or Q. sessiliflora, does not appear); and the Pine is the Pinus maritima. Those cut in 1854 measured the tenth of a mètre (or 4 English inches) in diameter at the base, and 4 mètres (or 13 feet 4 inches) high.* They had been taken up and officially sealed (or stamped) by the magistrate himself, from a plantation of seedlings of about 200 hectares (494 acres), in presence of a former Inspector of Forests, who had assisted in sowing them, as well as eight other persons, all of whom had sown (or seen sown) these Landes. The *Agricultural Society of the Gironde* had watched and attested the striking vigour of the nursery plantation in question, and had adjudged 2 Gold Medals to the cultivator. These trees, the oaks especially, are beyond comparison the most favourable results that have ever been

* Some cut in 1855 and exhibited, were 17 and 18 feet high and 9 inches in circumference. Sections are in the Kew Museum.

obtained. For, though the soil of the Landes generally suits oaks and firs, the casually sown plants never exceed, in the same length of time, a height of 5½ feet to 6½ half feet.

The causes of the more favourable result seem to be:—

1. The draining work which was performed before sowing the seeds, whereby the ground, which had always been covered with water in winter, is comparatively dried.

2. The arrangement of the seedlings in regular beds, intersected by open spaces, through which wind and air have free passage; and

3. The facility with which it thus becomes practicable to water the ground, in the driest summer, by cheap and expeditious modes, and thus to moisten and fertilize this vast area of the Landes, where a burning sand shows no trace of surface water.

The details of the expense are fully given in the pamphlet, and may be summed up in rough numbers by saying, that the expense of each hectare (2½ acres) containing 400 mètres (or 1,300 feet) of draining-cuts, and 6 plantations of seedlings, 90 mètres (or 300 feet) long by 10 mètres (33 feet) broad, amounted to only 52 francs and 20 centimes (2*l.* 2*s.*) including the trenching and digging, the purchase of the seed, and the planting of it.

"We have since, says M. Chambrelent, sowed 300 more hectares (740 acres) on the same principle, and with equal success, as testified by the committee sent from the Agricultural Society of the Gironde; and a very much larger extent of ground (3,500 hectares) 10,500 acres, has been similarly treated by a society which pursues our method.

"Nothing is now required for these nursery grounds than to let them alone: the trees will grow; and in 6 or 7 years after each sowing the produce will suffice to pay all expenses, and, judging by the oaks, may be calculated as eventually yielding annually, as much as 150 francs (6*l.*) a hectare (2½ acres)."

Natural state of the Landes.

After stating these effects it seems well to glance at the country which has been hitherto so deplorably sterile, and which promises to be so valuable in future, and to say a few words on the improvement and culture of the Landes.

The vast territory which is thus named is described in the pamphlet as lying between the sea and the valleys of the Garonne and the Adour. Its scattered huts and isolated clumps of fir are inaccessible in winter, by reason of the inundations of the surrounding country. And yet this desert is close to one of the largest towns of France, it enjoys the mildest of European climates, and is traversed by the Bayonne railway. Most important would it be to cultivate this great

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extent of country, and many attempts have been made, but they have failed, through ignorance of the soil and its capabilities and its defects.

France.

The Landes are farther described by M. Chambrelent, an almost perfect level, from 160 to 190 feet above the sea; the surface is sandy and arid, about two feet deep, resting on a stratum of impervious subsoil: it is composed of vegetable substances and sand, and is, in fact, a sort of cement; its name in the country is *Alios*. No spring of water, whatsoever, exists on the surface: no moisture is perceptible in summer; while in winter the abundant rains, which characterize the vicinity of the ocean, fall in prodigious quantities for half a year, and finding no escape, either by superficial flowing or internal filtration, they remain stagnant till dried up in summer. Thus the district passes from half a year's inundation in winter to burning sands in summer. The distressing consequences to man and beast may be imagined; sickness and sterility ensue. And yet, experience has shown that, by processes nowise costly, the soil may be both dried in one season and moderately moistened at another, and that the profit will be incalculably great.

Improvement to be expected.

It is obvious that trenching and draining, cutting through the hard surface, and carrying the cuttings in a direction which shall take advantage of the, however slight, natural slope of the ground, are the first requisites. The objections commonly raised to open ditches, viz., that they take up space, and that manure is washed into them and wasted, are inapplicable in the case of the Landes; first, because the ground is comparatively little worth; secondly, that the plantations of young trees absolutely demand free ventilation; and, thirdly, in the matter of manure, that none is used or needed. These trenches are also a valuable safeguard against the destructive conflagrations which often prevail, in fir forests more especially, and wherever the soil is much overgrown with heath and brake, or strewed with branches and dead leaves.

Trees will gradually improve the pure sand of the Landes and render it capable of agricultural operations; and all the more surely because, bad as the soil is, it is not unfavourable to the fir and the oak, as may be seen by the magnificent specimens of these trees which always establish themselves in spots where there is a comparative exemption from inundation and from scorching.

Especially a supply of valuable trees.

Trees, too, are a marked desideratum in France, especially for ship-building. Ever since the revolution of 1789, which was followed by the subdivision of land into innumerable small holdings, forests and woods have yielded more and

more to the axe; and no new plantations having taken their places, the country is becoming gradually denuded of trees.

Already, independent of the 3,500 and the 500 hectares (10,000 acres) which are described, a great Insurance Company and several large capitalists have turned their energies to the subject; and the President of the Association of the South, whose views on behalf of the Landes are very discriminating and liberal, even now possesses more than 10,000 hectares, (25,000 acres,) which will shortly be covered with seedling trees, and which will prove one of the most extensive forestal improvements in France.

Government is now carrying new roads through the Landes. The railway facilitates this operation; and incalculable will be its benefits, especially in aiding agriculture, and thus bringing some profit out of the soil.

In this Class a Silver Medal was awarded to *M. Chambrelent.*

Various samples of *Woods* for *Cabinet-work* and other purposes are exhibited by different persons, but none are of a remarkable character.

Mr. Millett, being engaged in a series of scientific experiments on the growth of trees as affected by the nature and peculiarities of the soil, exhibits a considerable number of specimens of the woods, and soils and rocks, from the forests of France.

M. Mocquerys on injurious and useful insects.

Insects injurious to woods, and the woods thereby injured, and insects serviceable to agriculture, are exhibited by M. Mocquerys, (Rue Grand Pont, Rouen), under the head of "*Entomologie appliquée.*" They are beautifully prepared in five large glazed cases; the insects are correctly and scientifically named; and such a collection cannot fail to be of great service to foresters, and to horticulturalists and agriculturalists generally in Europe; for without an acquaintance with the causes of the mischief done to trees and plants it is vain to attempt a remedy, and unless useful insects are known to us they will be liable to share the fate of the destructive ones. A collection of this kind already exists at the Museum of the Royal Gardens of Kew, which, by the purchase and addition of that now under consideration, is rendered extremely valuable. The following is a summary of the contents of the cases of M. Mocquerys:—

Woods injured by certain Insects.

Damage done to woods by certain insects.

1. *Oak wood*, bored by the larvæ of *Cerambyx Heros.*
2. *Oak wood*, of which the heart and knots are pierced by the larvæ of *Mesosa nubila.*

3. *Beech wood*, furrowed by the larvæ of *Phymatodes variabilis*, and the holes whence the insects emerged.

4. *Beech wood*, pierced by the larva of *Clytus mysticus.*

5. *Apple-tree wood*, perforated by the larva of *Cerambyx Cerdo ;* the insect, captured in its gallery, and the hole whence the perfect insect emerges.

6. *Apple-tree wood*, furrowed and perforated by the larvæ and perfect insects of *Sinodendron cylindricum.*

7. *Chestnut wood*, furrowed by the larva of *Hylotrupes Bajulus.*

8. *Chestnut wood*, perforated by the larvæ of *Clytus Arietis.*

9. *Hornbeam wood*, furrowed by the larvæ of *Callidium Alni.*

10. *Branches of the Aspen Poplar*, distorted and pierced by the larvæ of *Compsidia populnea.*

11. *Elm bark*, channelled by the larvæ of *Scolytus destructor ;* and ditto, furrowed in all directions by the larvæ of *Scolytus pygmæus.*

12. *Fir-bark and wood*, the bark is loosened from the tree by the work of the larvæ of *Hylurgus Piniperda*, and the wood is full of holes, whence the perfect insects emerge.

13. *Ash wood*, and two pieces of *bark*, the latter seen within as attacked by the larvæ of *Hylesinus Fraxini*, and externally showing the holes of exit of the insect ; also the wood grooved by the passage of the larvæ.

14. *Lime branches*, of which the bark is bored by the larvæ of *Hylesinus serraticornis.*

15. *Hasel branch*, perforated by the larvæ of *Clytus Arietis.*

16. *Maple branch*, grooved by the larvæ of *Hylesinus vittatus.*

17. *Fir-bark*, detached by the action of the larvæ of *Pissodes notatus.*

18. *Apple-tree wood*, containing the channels of the larvæ and the habitation of a family of *Tomicus monographus.*

19. *Pear-tree Wood*, pierced like a sieve by the larvæ of *Valgus hemipterus.*

20. *Elm wood*, perforated by the larvæ and perfect insects of *Rhyncolus cylindrirostris.*

21. *Beech wood*, punctured and perforated by *Phlæophagus æneopiceus.*

22. *Fir wood*, injured by the larvæ and perfect insects of *Anobium Pertinax.*

23. *Wallnut-tree wood* (seasoned), perforated by the larvæ of the same.

24. *Beech wood*, pierced by the larvæ of *Anobium tessellatum.*

25. *Oak wood* (seasoned), furrowed by the larvæ of the same.
26. *Poplar wood*, attacked by the larvæ of *Hedobia imperialis*.
27. *Osier boughs*, attacked by *Cryptorhynchus Lapathi*.
28. *Fir branches*, attacked by *Pissodes notatus*.
29. *Wheat grains*, attacked by *Sitophilus granarius*.
30. *Maize*, attacked by *Sitophilus Oryzæ*.
31. *Peas*, attacked by *Bruchus Pisi*.
32. *Lentils*, attacked by *Bruchus rufimanus*.
33. *Lentils* (Egyptian), attacked by *Bruchus Mocquerysii*.
34. *Beans*, attacked by *Bruchus flavimanus*.
35. *Vetches*, attacked by *Bruchus granarius*.

COLEOPTEROUS INSECTS,—*Injurious to Agriculture, Horticulture, Sylviculture, &c.*

Insects which are eminently destructive to grain, wood, &c.]

1. *Melolontha vulgaris*, Linn., *M. albida*, Dej., and *M. Hippocastani*, Fab. All these insects, whether in the perfect or grub state, do considerable damage to crops of grain and to forests; as grubs, they eat the seeds, and when perfect, they strip the trees of all their foliage.

2. *Rhizotrogus æstivus*, Oliv.
3. *Amphimallus ater*, Herbst.
4. ,, *rufescens*, Lat.
5. ,, *solstitialis*, Linn.
6. *Anomala Julii*, Pkl.
7. *Phyllopertha horticola*, Linn.

All these have the same habits as the *Melolonthæ*.

8. *Agriotes graminicola*, Linn. This insect lives indiscriminately on the roots and stems of *Rye, Wheat, and Barley*.

9. *Agriotes Segetis*, Bierk. The larva, in gnawing the root-stock of the *Oat*, destroys every plant which it attacks.

10. *Sitophilus granarius*, Linn. Whether in the larva or perfect state, this insect does infinite mischief in *Corn* granaries, destroying an immense quantity.

11. *Bruchus Pisi*, Linn. In the larva state it pierces the *Pea*, and remains there till perfect.

12. *Bruchus flavimanus*, Shr. The *Bean* is attacked by the larva of this insect, which only emerges when perfect.

13. *Bruchus rufimanus*, Shr. Equally destructive to *Lentils*.

14. *Bruchus nubilus*, Dej. It destroys *Vetches*.

15. *Apion apricans*, Herbst. As a larva, this insect completely destroys *Clover seed*.

16. *Altica oleracea*, Fab. The *Rape* and many other allied plants are entirely stript of their leaves by this insect.

17. *Altica Lepidii*, Ent. H. It infests all the *Cruciferæ*, and utterly destroys their leaves.

18. *Altica atra*, Pkl., and 19, *A. Brassicæ*, Fab., have the same habits.

20. *Psylliodes Rapæ*, Illig. Still more ruinous than the three preceding to the *Cruciferæ*.

21. *Phyllobius oblongus*, Linn. It gnaws and destroys the grafts of *Fruit-trees*.

22. *Bromius Vitis*, Fab. It subsists on young *Vines*, gnawing their leaves and young buds.

23. *Centorynchus sulcicollis*, Gyll. In the larva state, it causes tubercles on the root-stock and roots of *Cabbages*.

24. *Hylurgus Piniperda*, Linn. It resides in the larva state between the bark and wood of the *Fir*, and in the perfect state it cuts off the young shoots as clean as could be done by the gardener's shears.

25. *Hylurgus Ligniperda*, Fab. Prodigiously destructive to the forests of *Coniferæ*.

26. *Hylastes ater*, Pkl. Same habits as the previous species, and equally addicted to cutting off the shoots of young resinous trees.

27. *Pissodes notatus*, Fab. It injures orchard-trees and young *Firs*.

28. *Hylobius Abietis*, Linn. Ditto.

29. *Agrilus cyaneus*, Oliv. The larvæ destroy the *Oak, Beech, and Birch*.

30. *Cerambyx Cerdo*, Linn. The larvæ live withinside the wood of the *Apple-tree*.

31. *Ægosoma scabricornis*. The larvæ inhabit the wood of the *Willow* and *Plane-trees*.

32. *Anœrea Carcharias*, Linn. The larvæ live inside the wood of *Poplars* and *Aspens*.

33. *Compsidia populnea*, Linn. Nearly the same habits as the two preceding species.

34. *Saperda scalaris*, Linn. Both in the larva and perfect state it perforates the *Apple-tree*.

35. *Clytus arcuatus*, Linn. It perforates the seasoned wood of the *Elm* with numerous holes.

36. *Clytus quadripunctatus*, Fab. Ditto the *Birch*.

37. *Clytus Arietis*, Linn. Ditto the *Beech* and *Elm*.

38. *Clytus mysticus*, Linn. Ditto the *Beech*.

39. *Phymatodes variabilis*, Linn. Ditto ditto.

40. *Callidium sanguineum*, Linn. It pierces, with many channelled holes, the wood of the *Oak*, when seasoned for use.

41. *Callidium Alni*, Linn. It attacks and destroys the growing *Alders*.

42. *Mesosa nubila*, Oliv. It perforates the *Oak* with many tubular holes.

COLEOPTEROUS INSECTS,—*which are beneficial in Agriculture, Horticulture, and Sylviculture, &c.*

Insects which are useful to grain, wood, &c.

1. *Cicindela campestris*, De Geer. Insects which are carnivorous and subsist on other insects, and which, therefore, both in the perfect and larva state, destroy great numbers of the injurious kinds.

2. *Cicindela hybrida*, Linn. The same habits.

3. *Procrustes coriaceus*, Linn. This insects lives chiefly on the caterpillars of the forests.

4. *Carabus auratus*, Fab. In both states this insect wages constant war against snails, caterpillars, and larvæ, of which it destroys a prodigious quantity.

5. *Carabus auro-nitens*, Fab.
6. „ *catenulatus*, Fab.
7. „ *purpurascens*, Fab.
8. „ *nemoralis*, Mull.
9. „ *monilis*, Fab.
10. „ *cancellatus*, Illig.
11. „ *granulatus*, Linn.
12. „ *arvensis*, Fab.
13. „ do. var. *Pomeranus*, Oliv.
14. „ *convexus*, Fab.
15. „ *intricatus*, Linn.

} of precisely similar habits.

16. *Calosoma sycophanta*, Linn. It subsists on all caterpillars, especially the processionary kinds.

17. *Pœcilus cupreus*. Linn. Equally addicted to the destruction of injurious insects.

18. *Omaseus melanarius*, Illig. The same habits.

19. *Steropus madidus*, var. *concinnus*, Fab. Ditto.

20. *Abax striola*, Fab. Ditto.

21. *Staphylinus nebulosus*, Fab. These insects, in both states, prey exclusively on snails and caterpillars and kill great quantities of them.

22. *Staphylinus murinus*, Linn.
23. „ *cesareus*, Cedh.
24. „ *chalcocephalus*, Fab.
25. *Ocypus oleus*, Muller.
26. „ *cyaneus*, Pkl.

} The same habits.

27. *Silpha quadripunctata*. It lives in forests, and subsists on the caterpillars which are found there.

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28. *Thanasimus formicarius*, Fab. Both in the larva and perfect state it actively preys on the larvæ which infest wood, and particularly those of the Bostrichi.

29. *Lampyris noctiluca*, Linn. These insects, commonly known as glow-worms, feed, when in the larva state, on the garden snail.

30. *Drilus flavescens*, Fab. This insect also subsists on snails and slugs.

31. *Coccinella septempunctata*, Linn. The larvæ feed exclusively on the wood-lice which infest so many of our plants.

32. *Adalia bipunctata*, Linn.
33. *Myrrha octodecimguttata*, Linn.
34. *Propylea quatuordecimpunctata.*

} The same habits.

Basket-work: the best osiers for the purpose.

Basket-work.—There were many beautiful samples of "*vannerie*, fine et commune," and, what was more to the purpose of our Class, good samples of the raw material as cut from the osier-grounds, accompanied in one instance by an excellent pamphlet which merits wide circulation. It is entitled "Traité pratique de la culture de l'Osier et de son usage dans l'industrie de la vannerie, fine et commune, orné de quatre planches, suivi d'un aperçu sur l'art du Vannier, par A. Moitrier, ancien ouvrier Vannier. The kinds M. Moitrier recommends for the best twigs are, 1. "*Le Romarin ou Queue de Renard*," the best of all; 2. "*La Petite Grisette*," of good quality, but not of such vigorous growth as the preceding; "*l'Osier noir*"; "*l'Osier vert ou franc, et la Gravalanche:* these two of good quality. Such are the "noms du pays" in the osier districts of France; and if the botanical names had been given, other countries would have benefitted the more by this pamphlet.

Acacia tree; its utility.

Acacia-hoops.—M. Moussillar, of Rêole, Gironde, exhibited a "Meule de douze cercles d'acacia," and happily accompanied by a pamphlet entitled "Observations sur la culture et l'utilité de l'acacia (Robinia pseudo-acacia)." Here seems to be another of the many uses for which this graceful tree, a native of the United States, may be advantageously employed. The attempt for cultivate this tree for profit in England, at the suggestion (and mainly from the nursery) of the celebrated Mr. Cobbett, proved a failure; our climate not being such as to bring the tree to perfection except in sheltered positions, the branches were very brittle. But in France the hot summers are favourable to the ripening of

the wood, and one sees even the waste ground along the sides of the railway, lines bordered with this tree. If experience should prove the correctness of M. Moussillar's statements, it is well worthy the attention of foreign arboriculturists.

Many interesting *Economical Plants* in the rough state (produits brutes) are in the section, called Produits Chymiques, viz.— Some useful plants.

Zostera, for making paper, (in many northern countries the same substance is extensively collected for stuffing cushions, pillows, and mattrasses). Noble specimens of *Kousso* (*Brayera anthelmintica*). *Angelica, roots and seeds* (the former very large). *Cudbears* from various localities; and *Orchills.*

M. Mocquerys received "Honourable Mention" for his collection of insects, *M. Moitrier* for basket-work, and *M. Moussillar* for hoops of acacia.

XXXVII.—GREAT BRITAIN.

(Commissioner: Henry Cole, Esq., C.B.)

As might be expected, wherever the land is extensively and highly cultivated, and where the arts are brought to great perfection, there, as in Great Britain and its sister country, France, and in Northern Europe generally, we find great richness in *manufactured* articles, and corresponding poverty in those productions which fall under our Department, namely, *Raw Vegetable Products.* The native *Woods** of the United Kingdom are known to every one; and its *Fibres* are chiefly exhibited in the marketable form, being, indeed, mainly derived from cultivated plants. Some objects, however, are worthy of notice, though generally ranged under heads alien from Class II. British collection: unavoidably limited, as to wild native productions, the land being too generally cultivated.

British Agriculture, for example, was admirably represented (by the Board of Trade): it included a good collec-

* In the "Notes on the Trade and Commerce of the United Kingdom," given in the "Catalogue of the Woods exhibited in the British Section of the Paris Universal Exhibition, 1855," the Forests are alone and very slightly noticed, to the effect that the gross value of timber in England and Wales is estimated at from 40 to 50 millions sterling; that in the total area of the Royal Forests there are 122,622 acres; that 51,612 acres besides are enclosed for the growth of timber; and that the entire extent of woodland in Scotland is calculated at about one million of acres. Ireland is, comparatively, destitute of timber.

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Great Britain.

tion of *Woods* used for construction,* both native and cultivated exotics, though very inferior to the Woods shown by Peter Lawson and Sons, in the Crystal Palace of 1851.

A Collection, still more interesting, because more difficult to be obtained, included the *Cones* of the various *Pines* which have been recently introduced into our arboreta and pleasure-grounds, especially from the Himalaya Mountains, and from the New World.

From the United States, Oregon, California, and the elevated regions of Mexico, there were *Fibres* of various kinds, and native *Dyeing Materials.*

Messrs. Lawson's agricultural and economic collection.

This vast collection was principally formed in Scotland by Messrs. Peter Lawson and Son, whose own exhibition in the Crystal Palace in 1851, must be fresh in the recollection of every one. All the objects have been arranged under the superintendence of Professor Wilson, the distinguished individual who holds the Chair of Agriculture in Edinburgh.

The two following collections are placed in the Educational Department, but they assuredly deserve notice from our Class.

Mr. Archer's cabinet.

Mr. Archer, who collected the Liverpool imports which were exhibited in 1851, and who is the intelligent author of *Popular Economic Botany*, sends a *Cabinet* with 8 drawers, each divided into compartments which hold specimens of the more important Vegetable Products, correctly named, viz.,

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* Professor Wilson, in his admirable lecture delivered at Edinburgh and since published, "on the Agriculture of the French Exhibition," has the following remarks on timber for naval purposes: "In ship-building, about 40 cubic "feet (in round numbers) are required per ton,—say 32 cubic feet for the hull, "and 8 for fittings: this would give for a ship of 1,000 tons, 32,000 + 8,000 "cubic feet. The two main elements for the builders' consideration are strength "and specific gravity, both separately and in relation to each other. The value "of the former is not so generally determined as that of the latter, which was, "for that reason, the principal object of the experiments alluded to. Let us see, "therefore, how far the specific gravity of the timber influences the ship. The "*first-class Woods* entered at Lloyd's are eight in number, viz., *English Oak*, "*American Oak, African Oak, Morung Sal or Malabar Teak, East India Teak*, "*Greenheart, Mora, and Iron-Bark*; and these differ considerably in specific "gravity. A cubic foot of English Oak weighs 40 lbs.; of American Oak, "46 lbs.; of African Oak, 50 lbs.; of Malabar Teak, 39 lbs.; of Mora, 62 lbs.; "of Iron-Bark, 65 lbs. Besides these, other Woods are largely used, as *Hon-*"*duras Mahogany*, which weighs 31 lbs. per cubic foot; *Eucalyptus*, 50 lbs.; "*Canada Pine*, 22 lbs.; and *Cedar*, 25 lbs.

"Now, taking these specific gravities into calculation, the hull of a 1,000 ton "ship would require, of English Oak, 572 tons; of American Oak, 657 tons; "of African Oak, 714 tons, of Teak, 537 tons; of Mora, 885 tons; of Eu-"calyptus, 714 tons; and of Iron-Bark, no less than 930 tons While it would "require of Mahogany only 443 tons; of Canada Pine, 316 tons; or of Cedar, "362 tons. Taking the two extremes, Iron-Bark and Canada Pine, a difference is shown of 614 tons, nearly 200 per cent., in the displacement tonnage of the vessel, and in the consequently increased capacity for freight."

1, Fibres. 2, Miscellaneous. 3, Spices. 4, Materia Medica. 5, Dye-Woods. 6. Dye-Stuffs and Tannins. 7, Hard Woods. 8, Building-Woods:—a very extensive and useful series.

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The *Rev. J. S. Henslow*, Professor of Botany in the University of Cambridge, exhibits two large cases containing a most extensive series of *Fruits and Seeds* analyzed, showing their external and internal structure, the embryo and its different parts, the albumen, &c., &c., illustrated by drawings and engravings and by models of wax (the latter are unfortunately almost destroyed, probably from the package containing the cases having been placed near the furnace or funnel of the steam-vessel which conveyed them). The whole is a work of great industry, and exceedingly instructive, displaying much botanical knowledge. A Silver Medal was awarded. It would have been better appreciated by the Jury of Class II.

Professor Henslow's fruits and seeds.

British Herbs and Extracts.—About 100 beautifully prepared British Medicinal Herbs and Extracts. The colour and forms of the plants, whether dried or as in some instances immersed in liquid, are most wonderfully preserved by processes peculiar to *Mr. Kent*, the exhibitor, a gentleman who obtained much and deserved notoriety at the Exhibition of 1851, by his Pharmaceutical preparations of British Herbs, now in the Museum of the Royal Gardens, Kew. The present collection far excels Mr. Kent's first series, and by the Jury of Class XII. was considered to merit the Silver Medal.

Mr. Kent's British medicinal plants.

XXXVIII.—SWEDEN.

Sweden.

(Commissioner: M. C. Brandstrom.)

Swed collection: highly respectable, contains fine specimens of trees.

Considering the northern position of this country and its therefore limited amount of useful Vegetable Products, it makes a fair figure in the Exposition, chiefly, indeed, by its *Woods*. There are sections of very fine trees:—*Pinus Abies*, 4–5 feet in diameter; *Pinus sylvestris*, 4 feet. *Alnus incana*, the Northern or Mountain Alder, is a tree now extensively reared, and on the Swedish mountains it grows rapidly, making excellent charcoal, and attaining a diameter of half-a-foot in 10 years. Sections, three feet across, are in the Exhibition. *Beech* is four feet in diameter. *Birch* is much used for boxes. Excellent basket-work is shown of peculiar make, woven of the bast of *Lime*, and dyed blue at the edge with a mountain berry (*Vaccinium*). These baskets are sold for a sou and a half. A handsome cabinet with drawers, made of the *Mountain Elm* (Ulmus montana); beautiful coopers' work in small barrels for holding snuff; and hand-

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France.

Articles made of wood; as matches.

some drinking-cups and buckets, with lids, the bottoms of *Beech*, the sides of *Juniper*, and the slender hoops of *Willow*: all these are offered at extremely low prices. *Pinewood* is extensively used in Sweden for making *Matches*, and remarkably neat *Allumettes* are prepared of it. A manufactory of these articles was established in 1845, at Jonköping, which employs about 400 workmen. The machines for cutting the matches are propelled by a steam-engine, and they turn out about eight millions of matches, in 80,000 wrappers, every day. The chief sale is in Sweden, Norway, and in England. These matches are said to be remarkable for their easy, silent, and infallible ignition, during all states of climate and of weather, which renders them peculiarly valuable for sea-store; while the mode of packing them securely guards against spontaneous ignition. They are also safe from explosion, being made without any phosphorus or such substance, and they are kindled by very slight friction, without blaze, smoke, or disagreeable smell. Specimens of the matches from the manufactory are exhibited.

Maize in Sweden.

One is surprized to see plants of *Maize* which had grown and ripened in Sweden. At Smoland, in the south part of the kingdom, they had attained to 11–12 feet long in two months. The soil is rich and the maturing of the grain is alleged to be due to the strong and long-continued action of the sun.

In this Class a Bronze Medal was awarded to *M. Mannerskauts* for samples of Woods.

Norway.

XXXIX.—NORWAY.

(Commissioner: M. E. Tidemand).

Norwegian collection: a few woods only.

Norway contributes nothing to our Class and Section but very fine planks and boards of Spruce (*Abies excelsa*) and sections of trunks and planks of Pine (*Pinus sylvestris*), pitch and tar and other products of the Pine tribe, panniers made of roots of trees, and boxes neatly carved by the peasantry, especially of Birch and Lime. Various Woods, viz., Alder, Oak, Beech, Birch, Spruce, Elm, Juniper, White-Beam (Pyrus Aria).

Switzerland.

XL.—SWITZERLAND.

(Commissioner: M. Le Colonel Barman).

The Corporation of the Bourgeoisie of Neuchatel send specimens of Spruce from the forests of La Joux.

XLI.—GRAND DUCHY OF BADEN.

(Commissioner : M. DIETZ, Counsellor to the Minister of the Interior of the Grand Duchy),

Exhibits a collection of all the kinds of *Useful Timber* (Bois de sciage) of the Grand Duchy, and a collection of cut laths and planks (planches et lattes sciées).

XLII.—PRUSSIA.

(Commissioner : M. GEORGE de VIEBAHN).

Oak staves are exhibited in this Class, and *Moss*, (Polytrichum commune*) raw and manufactured into *brushes* and *brooms*.

XLIII.—SAXONY.

(Commissioner : M. le DOCTEUR WALDEMAR SEYFFARTH).

Thin sheets (feuilles) of *Acacia* and *Maple*, cut with a circular saw.

SUMMARY.

Summary of the Report, its object, &c.

WITH a view to the chief object of this Report, as contained in the instructions of the President of the Lords of the Committee of Privy Council for Trade; viz., "*The Vegetable Products obtained without culture, and contained chiefly in the sixth section of Class II.* in the PARIS UNIVERSAL EXHIBITION of 1855, *viewed with special reference to the position which the United Kingdom there holds as compared with Foreign Countries, and to the progress, if any, which has been made since* 1851," it becomes my duty, after the preceding notice of the several collections of this class and section, and the occasional remarks thereupon, to institute this comparison and to draw my conclusions. And this I shall do as briefly as the subject will allow, and with all practicable care. It must be confessed, that in comparing the London Exhibition of 1851 and that in Paris of 1855, a difficulty arises from the different arrangement in the respective Exhibitions and catalogues; for, whereas in the Paris Exhibition these vegetable products are chiefly comprised, as just observed, in Class II. and Section 6, and each country has its contributions

* In many rural districts of England and Scotland excellent brushes and brooms, hassocks and baskets, are made of the long wiry stems of this abundant moss.

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so classified: in the English Exhibition and Catalogue there is a double arrangement; 1stly. A classified series, according to the nature of the products of *British* contributors; and 2dly, of colonies and foreign countries. In the Colonies, the objects belonging to our class and section stand in the catalogue without any sort of order or arrangement, while in the classified series they are placed in three different classes; for example, under 1, "Chemical and pharmaceutical products;" 2, under "substances used as food;" and 3, "vegetable substances used in manufactures:" and these three classes are by no means confined to the products to which our attention was to be especially directed.

It should be borne in mind also that my duties are restricted as much as possible to vegetable products obtained without culture, and chiefly to raw materials, and to a notice of their immediate uses and applications, exclusive of the more finished and manufactured results, thus embracing objects often little attractive to the eye of a casual visitor, but which are, nevertheless, of the highest consequence to trade and commerce, medicine, the arts and domestic economy, &c., as affording materials for the artisan and mechanic in a thousand different ways.*

Utility of collections much dependent on the information sent with them.

It must be confessed, indeed, that the value of such collections as have appeared in our two great Exhibitions does not depend so much on their quantity or variety as upon the information with which they are accompanied, either attached to the samples or given in Catalogues, or described to the juries by the exhibitors, and the correctness of the names and of the localities of the plants yielding their several valuable products. This cannot be accomplished to any extent and with a certainty of beneficial success without the aid of science, and especially botanical science; and it will be incumbent on me to show that rich as is the collection now under immediate consideration in the Paris Universal Exhibition, and superior as it must rank in that point over the London Exhibition of

* It is well known that this section of Class II. was mainly represented in the *Annexe* of the Great Paris Exhibition, and we gladly quote the remarks upon this section given in the "Times" newspaper of September 26th, 1855:—"The *Annexe* is not the most brilliant part of the Paris Universal Exhibition; but it commands by its contents the highest degree of attention and interest. While idle curiosity exhausts itself upon the more showy products of *industry* which are collected in the main building, here will be found the men who look carefully at the great sources of employment and national wealth, whose strong and masculine minds teach them to regard with feelings akin to contempt the thousand forms into which the caprices of fashion and taste cause the labour of the world to efflorese. Their thoughts are fixed with unalterable constancy upon those deep-set and broad foundations on which the fabric of human industry is raised, upon materials which the beneficent Creator has supplied in such abundance for our use."

1851 (indeed, it would be strange if it were not so, after the glorious example set them on the previous occasion), yet the want of scientific knowledge, and of accurate, or even any kind of information, has rendered collections that might have been of the greatest importance to the countries producing them, and to the world at large, worse than useless, a disappointing heap of mere rubbish. Products are sent without even names; and very frequently names are attached to products with which they had no sort of connexion.

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Scientific knowledge indispensable.

I proceed now to offer a few remarks on the relative collections in the Exhibitions of 1851 and 1855.

Comparison of collections exhibited in 1851 and 1855; general superiority of the latter. Indian collection.

I. INDIA AND THE INDIAN ARCHIPELAGO (p. 4). It is well known what exertions were made and with what success by Dr. Royle, under the auspices of the India Company, to render its contributions to the 1851 Exhibition worthy of so vast and valuable a territory as India, and of those who govern it. Still greater preparations were made for Paris; and it has been stated, we believe on good authority, that no less a sum than 60,000*l.* was expended, and well spent too, by the Indian Company in the preparations for the Paris Exposition Universelle. Thus not only are the collections in our department (and the highly finished articles of vegetable origin in a still greater ratio) vastly increased, but the means of inspection are much facilitated by the arrangement of the raw products, especially of the fibre, each in its proper family to which it belonged, an arrangement due to the scientific knowledge of Dr. Royle.* In one department only, did we note a deficiency as compared with 1851, and that was in the collection of woods; and this we can attribute to two causes; firstly, to want of space for such very bulky objects as would fitly represent the forestal value of so great a portion of Asia; and secondly, the fact that there was little to add in that branch to what was shown in 1851. But, if the raw material was not here adequately represented, the various manufactured articles of native and other workmanship exhibited in the gallery of the Palais, were of the highest beauty and interest. Long as our notice is (relating to the raw products, p.p. 4–32, &c.), it would have required greater extension, but for the accurate history of the same objects given in the reports of the Juries for

* Mr. Hanbury, however, when describing the Materia Medica department, had occasion to observe in this vast collection of raw products derived from the animal, vegetable, and mineral kingdoms, a very defective arrangement, owing to the want of suitable bottles for the display of specimens, and the absence of intelligible labels, so that nothing like a thorough enumeration could be accomplished. This difficulty of the Jurors was removed by the use of a manuscript catalogue. (*Pharmaceutical Journal, December* 1855.)

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1851; and the still more elaborate writings of Dr. Royle himself during the interval of the two Exhibitions; to which must be added the valuable reports on the Madras collections by Dr. Cleghorn and his able coadjutors, though the latter were not sent to Paris. And herein is shown in a very remarkable degree the superiority of the East India Company's collection over that of 1851, viz., in the amount of information given, and which is unsurpassed by any in our class, save that relating to the country which immediately follows.

Algerian collection in 1851.

II. Algeria (p. 33). The Official Catalogue of the 1851 Exhibition enumerates in our class only *vegetable hair* and patent *paper and paste-board* made of the leaves of the Algerian *dwarf palm tree*, an *aloes thread* cloak, five specimens of *veneering*, a few *oils*, *odoriferous essences* and *perfumed oils*, *paper of Aloes* and *Algerian Banana*, *baskets* of *leaves* of *a palm tree*, with a few other trifling articles and specimens of native *woods* and *cork*. The *woods*, as reported by the Jury, were fifty-three in number, accompanied by the French name, that of the genus (only) in Latin, a note on the dimensions, and half a line or rarely exceeding one line descriptive of the general properties: yet these were pronounced to be a "highly valuable collection of woods; the specimens are remarkable for their beauty and for the skilful and instructive manner in which they are exhibited; some of them are rather small, but in all cases they are characteristic and well selected." Yet, as regards the most remarkable of these woods for its beauty, and now acknowledged commercial value, viz., the "*Thuja*" (or Callitris quadrivalvis), the only remark is, "Thuja articulata Desf. ? 6 × 5 × 2; close grain; heart-wood hard, bright chestnut-coloured, resinous; recent layers cream-yellow. The wood is supposed to be the sandal wood of the ancients." It is needless to offer any further comparative observations between the Algerian collection of 1851 and that of 1855, which latter is unquestionably the only colonial collection which will bear comparison with the Indian one (No. I.), and which has this further merit, that the printed and extensively circulated descriptive matter is wholly confined to this collection, and is as valuable for its scientific information and correct nomenclature as it is for its bearing on commerce. In 1851, as justly remarked in the Official Illustrated Catalogue of that year:—"The natural sources of Algeria were only just beginning to be developed, and the promise of these, as may be in a degree estimated by the objects exhibited, is already important. A few textiles, medicinal substances and miscellaneous objects were shown." In 1855 no country has its native vegetable resources more

Its immense superiority in 1855.

fully developed and represented in the collection than Algeria.

III. Jamaica (p. 52). Our notice of the Jamaica collection, at the page now referred to, has but to be compared with the catalogue of 1851. "Jamaica is directly represented by only one exhibitor. The contribution consists of *artificial flowers* in imitation of the gorgeous productions of the tropics. The material deserves attention. It is obtained from one of the *Yuccas*, plants which are members of the natural order *Liliaceæ*; and being of tenacious fibre, are occasionally used in the manufacture of twine, rope, &c." Now it is candidly acknowledged by a Jamaica gentleman interested in forming the present collection, that it was the discredit of being so ill represented which led to the vast exertions made on the occasion of the French Exhibition, and to the scientific knowledge called into action, without which its utility would have been much diminished. "Let us not perpetuate our disgrace," said the colonists, "but endeavour by a combined movement to render justice to the land wherein our lot is cast. It were difficult to assign any good reason why the gifts of the God of nature, here so abundantly lavished, should not become articles of commerce, and be yet fabricated into forms of surpassing elegance and exquisite workmanship." And we are happy, to see it announced in the Journal of the Society of Arts for June 20, 1856, that the Jamaica Society (now in union with the Society of Arts in London), has received the gracious patronage of Her Majesty the Queen, and H.R.H. the Prince Albert, together with a donation of 150*l.* from the same royal personages in aid of a fund to enable the society to carry into effect its various objects. These objects are—1. Local Exhibitions. 2. A Museum, with library and lecture-room. 3. A Journal of Transactions. 4. Model Industrial and Reformatory Schools. 5. Horticultural and Experimental Garden. 6. Botanical Magazine.

Jamaica collection, *nil* in 1851; zeal to repair such neglect in 1855.

IV. British Guiana (p. 68) was no doubt fairly represented in 1851, especially in regard to our class. The woods were a marvellous collection, and many fibres were beginning to be brought into notice; but the colony has done itself great honour on the present occasion by increasing the collection in every department, and what is more, accompanying it by a catalogue raisonné, with the names as far as they could be correctly obtained, and excellent observations on their properties and uses.

British Guiana, collection good in 1851, better still in 1855.

V. Ceylon (p. 85), made a very poor figure in 1851. In 1855 it is valuable and attractive, and the catalogue is full and useful, but sadly deficient in correct nomenclature;

Ceylon collection indifferently named.

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merely for want, it appears, of calling in the services of the very able botanist, Mr. Thwaites, of the Botanic Gardens at Peradenia. If my preceding notice, especially of the timbers, at p. 87, tell a different tale, it is entirely owing to the Museum of the Royal Gardens at Kew having received a set of similar woods, inspected by Mr. Thwaites, whose names are adopted, to the great advantage of all interested in these important products.

New South Wales, collection very trifling in 1851; now rich, and with full information.

VI. New South Wales (p. 93). Under this head the Catalogue of 1851 is almost silent as to any objects of our class. Mr. Bidwill, indeed, exhibited a log of wood, the *Briggalo* of the squatters, from the Wide Bay district; Mr. Bogue a few specimens of colonial timber and a package of "*cabbage tree hats;*" and there were also some woods in the 1851 Exhibition from New South Wales; but all without any scientific names or notices, except of the most trifling and unimportant character. In 1855, thanks especially to Sir William MacArthur, here is one of the most attractive and useful series of vegetable products in the Exhibition, both raw and highly manufactured articles. The woods are of great beauty and value. The Catalogue abounds in useful scientific and commercial information. The plants yielding these various products are correctly named (wherever practicable), and we here learn, what the 1851 Exhibition could not tell us, that the cabbage-tree hats (cabbage-tree or palm being a name applied to very different palms from this) are made from Corypha Australis.

Victoria collection, small.

VII. Victoria, Australia (p. 104). This colony was not represented at all in 1851, as far as our class is concerned; so that small as is the present collection it is a step in the right direction; and with the good botanic garden and able colonial botanist, which Victoria possesses, there is no excuse for so little being known of its resources.

Van Diemen's Land collection below expectation.

VIII. Van Diemen's Land (p. 104). The excellent contributions from Van Diemen's Land to the Crystal Palace in 1851 led us to expect better things in the Paris collection, 1855; but we were disappointed. The active governor, Sir William Denison, who took such a warm interest in the colony in 1851, was no longer there in 1855. Still there are able men in the colony devoted to science, and among them Ronald Gunn and J. Milligan, Esquires, and they only need the encouragement of the higher authorities to induce them to aid in the development of the island's resources. At a very late period, too late for the jury to profit by it in Paris, Mr. Milligan did prepare and print in Tasmania a good scientific and, we may say, commercial

catalogue, which stamps a value upon the collection over and above that of 1851.

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IX. Canada (p. 110), stood high in the English Exhibition, but higher still in that of Paris, especially in the department of the woods, which may be considered the staple raw material of the colony. It will, perhaps, be difficult to glean any further information on the forest products than is here displayed in the noble "trophy" and in the smaller but more numerous series of specimens from Mr. Dickson and others, described in the publications illustrative of them, which were freely distributed.

Canada collection, rich in woods.

X. Cape of Good Hope (p. 114). But for the valuable aid given by two well-known botanists at the Cape, Drs. Pappe and M. Zeyher, the products exhibited from our extensive colony in South Africa would have been no better than those of 1851. The correct nomenclature of these gentlemen is their redeeming quality. Of none of our colonies, perhaps, is the botany so well explored as in that now under consideration; while, on the other hand, in few are the uses and properties of the plants and trees so little known and appreciated. From our recently acquired eastern additions to this colony, I do not remember seeing a single contribution; and yet it is remote enough from the "Cape" proper to yield a very different vegetation, and of a much more tropical character.

Cape of Good Hope,—no novelty but the nomenclature accurate.

XI. The French Colonies, exclusive of Algeria (p. 122). It does not appear that these colonies were in any way represented in the 1851 Exhibition; they stand, therefore, as peculiar to 1855, which is so far creditable to those countries and to the French nation; but justice was not done to the collection, which was neither arranged nor correctly named; or, where the right names existed, they were exceptions to the general rule. Several of those colonies abound in interesting and useful products.

XII. Pays Bas, principally the Indian colonies (p. 126). As this had no analogue in 1851, we are spared the duty of comparison, and need only refer to our notice of it at the page just mentioned.

The collections from XII. to XXXI. inclusive of small amount and little interest.

XIII. Mexico (p. 131). Next to nothing in 1851, and little better in 1855. There are, however, some curious products which deserve enquiry.

XIV. Guatemala (p. 132). What little is here exhibited is so for the first time. The resources of that fine region were in no way represented in 1851, and the same may be said of the following countries, as far as our class is concerned, or with very slight exceptions not worth recording, viz. :—

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XV. The Republic of New Granada (p. 133); XVI. Republic of Costa Rica (p. 133); XVII. Argentine Confederation, including Paraguay (p. 134); XVIII. Brazil (p. 134), one of the most rich in useful vegetable products, perhaps, in the world; XIX. St. Domingo (p. 134).

XX. Bahamas (p. 135). A colony of small dimensions, and the collection, small also, may be considered equivalent to that of 1851, and as more fully representing the raw produce than many other countries in our list of much greater capabilities.

XXI. United States (p. 135). Native vegetable products formed no part of the United States' Exhibition in 1851; and of the few articles noticed by us in 1855, we may say, as of the United States' Minerals in the Report for 1851, "They do not completely illustrate the sources of wealth in this department."

XXII. New Zealand (p. 136). The Report of the Jury for 1851 shows that, small as was the collection on that occasion, it was much superior to the trash exhibited upon the present; void of interest, void of novelty, and void of information.

XXIII. Hawaii (p. 136). One kind of nameless wood exhibited from this "Kingdom;" nothing in 1851.

XXIV. Sardinian States (p. 136). Save a "collection of walking-sticks," nothing mentioned in our class in the Report of 1851. The present collection has, therefore, slightly the advantage.

XXV. Pontifical States (p. 137). This and the six following, which, indeed, were equally favourably or unfavourably represented in 1851, are, with very slight exceptions, alike uninstructive and uninteresting, viz.:—

XXVI. Greece (p. 137); XXVII. Ottoman Empire (p. 137); XXVIII. Egypt (p. 138); XXIX. Kingdom of Tunis (p. 138); XXX. Singapore, Borneo (p. 138); XXXI. Mauritius (p. 138).

XXXII. Tuscany, (p. 139), was well represented in 1851, and still better in 1855. The remarkable products of the *wild asphodel* (Asphodelus ramosus) will be read with interest.

Spanish collection of woods, fairly good.

XXXIII. Spain, including Cuba (p. 142). As far as I can judge from the Report of the Jury of the 1851 Exhibition, the Spanish collection in our class at that period was very inferior, and the Cuba collection very superior, to ours. The forest resources of Spain, the *timbers*, the *charcoals*, the *cork trees*, are of great commercial value; and we were gratified to observe so much science exhibited in

the nomenclature. But it was mortifying to find that the three celebrated, yet, botanically speaking, little known trees of Cuba, are totally unnoticed among the products of that fine island, namely, the *Pine of Cuba;* the *Sabicou*, so much used in ship-building; and the *Bast* or *Lace-bark* of that country. Questions, these, of no small importance in a commercial view, and which we have happily (see p. 144) been able to answer, through the inquiries of an intelligent English traveller casually visiting that country.

XXXIV. Portugal and its Colonies (p. 145). On a par, perhaps, with the exhibition from the same countries in 1851, and very creditable, but more science is called into requisition in the Catalogue.

XXXV. Austria (p. 146). Highly as Austria ranked for its mineral wealth and manufactured articles in 1851, it appears to have been poor in our class; whilst in 1855, although we apprehend there was no deficiency in the articles above mentioned, there was much that is highly commendatory in the manner in which the vegetable resources are represented; and their value is greatly enhanced by the information that has been published upon them, especially by our friend and fellow juror, M. Kreuter.

French collection necessarily poor in native uncultivated products.

XXXVI. France, exclusive of its Colonies (p. 151). The remark made under the head of Great Britain (p. 161), holds good here, namely, that in countries where agriculture and the arts and manufactures have attained the highest degrees of perfection, the native productive resources are correspondingly poor, or they are familiar to every one. The objects to which attention is here called are of the forestal department, connected with the improvement of the forests, or with the uses and applications of the products. The process of Dr. Boucherie for preserving wood, by impregnating it with metallic sulphates, by application of which it is said that on the telegraphic lines belonging to the State of France a saving has been effected of 2,000,000 of francs, was, indeed, exhibited and explained in 1851. But there are other and very important objects noticed in our present Report unknown to that Exhibition; among which, the fact of the rearing of trees in the hitherto sterile lands of the Gironde, and M. Mocquery's beautiful contributions to our knowledge of insect economy, as injurious or beneficial to vegetation, especially as affecting native timber, are not among the least interesting. Nor was there in 1851 anything to bear comparison with M. Vilmorin's agricultural collection, which included many objects of our class.

XXXVII. Great Britain (p. 161). In our class, besides the *prepared* medicinal British herbs and extracts of

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British collection not generally remarkable.

Mr. Kent, very superior to those of 1851, which were, nevertheless, very highly esteemed, the chief objects are the native and cultivated *woods* and *fibres* and *dye-stuffs*, &c. of the agricultural collection, prepared under the superintendence of Professor Wilson of Edinburgh; and these will lose nothing by comparison with those of M. Vilmorin in the French department. The want of an illustrative Catalogue was felt in both collections; and my familiarity with those of the 1851 Exhibition (which now form part of the Economic Museum of the Royal Gardens of Kew), justifies me in considering this portion inferior to what was shown in London. The Rev. Professor Henslow's extensive and beautiful and very instructive series of sections of fruits and seeds, with drawings of the same, and Mr. Archer's samples of commercial vegetable products were, unfortunately, placed in the educational class.

XXXVIII. Sweden (p. 163), and XXXIX. Norway (p. 164), are well represented as concerns woods and forestal productions, of which there was nothing in 1851.

XL. Switzerland (p. 164). Nothing in 1851, and next to nothing in our class in 1855; nor from the three following countries, which conclude our list, viz.:—XLI. Grand Duchy of Baden (p. 165); XLII. Prussia (p. 165); and XLIII. Saxony (p. 165).

Concluding comparison of the two Exhibitions.

The above notice will show the great general superiority of the 1855 Exhibition over the 1851 Exhibition, by a comparison with the countries in the respective years (barring a few which exhibited *only* in Paris); but we here leave unnoticed several which were represented in our Class in 1851 and are not in 1855. For example, Jersey and Guernsey, Tropical Africa (*Gums, Resins, Woods*), New Brunswick and Nova Scotia, St. Vincent, Trinidad (a *very* valuable collection, due to the then Governor, Lord Harris, and the intelligent colonial botanist, Mr. Purdie: these, of our *own colonies*, send nothing in 1855. Of foreign States, China can scarcely be said to be represented in our Class II.; and Russia not at all.

Relative condition of British products, with remarks on progress since 1851.

And now we come to the two very important questions to be answered,—1. The "position which the sixth section of Class II. of the United Kingdom holds in the Great Paris Exhibition of 1855, as compared with foreign countries? and, 2. The progress, if any, which has been made since 1851?

In answer to the first of these questions, it may be deemed sufficient if I refer to the preceding pages of this Report, where I have endeavoured to bring forward the respective claims of the 43 contributing countries; and it will be at once seen how large a proportion is occupied by the British possessions; but if I am asked why this country stands so high above any other in the extent and variety of its "Récoltes des produits obtenus sans culture," I must candidly say, that I find an answer in the great commercial industry and energy of our nation, and in the vast extent and variety and climatic differences of our colonies whence are derived so many of the raw materials of the vegetable kingdom. Were Algeria as extensive a country as British India, and represented in the same proportion that it now is, the Indian collection would not have stood at the head of our Catalogue; and in more than one sense we are disposed to yield the palm of priority to Algeria, inasmuch as its productions are, for the first time, only recently explored, and its magnificent collection is accompanied by a full and complete and descriptive Catalogue, which does the highest honour to the Algerian administration.

It is a more grateful and not a difficult task to answer the second of the above queries, viz., "What progress, if any, has been made since 1851?" for this query is presumed to apply to the progress, not of Great Britain alone, but of all the exhibiting nations of the world at large. Here, too, the response is clear and satisfactory. The progress of our knowledge of vegetable substances has been very great during the period specified, even if we take the Great Paris Exhibition alone for our guide.

To render myself the more intelligible, it will be necessary to consider the condition of Section 6, Class II., in general, at the Exhibition of 1851, and that is best explained in the Jury Report of that period, p. 71:—"From the fact that this Exhibition is the first attempt to bring together a complete collection of the *natural raw produce of all parts of the globe;* and from the very different views which were entertained in various countries as to the nature of the Exhibition, and the kind of substances it was desirable to collect and exhibit, it necessarily follows that the collection, viewed as a whole, is very incomplete. In some cases abundant and numerous specimens have been sent of all the various kinds of raw produce constituting the staple productions of the country, their value and importance having been evidently felt and acknowledged; whilst in other instances, it is apparent that the mere raw materials of

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any manufacture have been regarded as of comparatively little importance, and either, consequently, are not shown at all, or else are but imperfectly and inadequately exhibited in the form of small or inferior samples." Happily, the greater part of these strictures is not applicable to the present Exhibition. Here are many collections that are, viewed as a whole, very complete; and, in most instances, the samples are copious and of superior quality. And certainly the knowledge that has been obtained and communicated, by descriptive Catalogues and other means, of the properties and uses of these products, in many instances accompanied by a correct nomenclature,—by which I mean the scientific appellation of the plant,—proving the origin of the products, the very plants from which they are derived, are most highly creditable to the gentlemen who undertook the formation of the collections. In the foremost rank of these will stand India, Algeria, Jamaica, British Guiana, Ceylon (if we include Mr. Thwaites' supplemental aid), New South Wales, Victoria (for woods), Van Diemen's Land (including Mr. Milligan's supplemental catalogue), Canada, Cape of Good Hope (wherever Dr. Pappe's and M. Zeyher's services were given), French Colonies (in part only), Indian Colonies of the Netherlands) only in a very small degree), Tuscany, Spain, and a few other countries where the raw products are of an unimportant character.

Small drawbacks, which are to be regretted.

With this high meed of praise, however, we must yet lament that in many instances the samples are too small to be really available for due inspection, and still less for the purposes of experiment; and from too many countries, some of them the very richest in promise, were exhibited samples with only local, too often Indian, names only, or no names at all, and without one word of information or explanation. Others there are with names that do not belong to them; or the same thing bears different names, or the same names are repeated to widely different plants. I am aware that correct, and especially botanical, names (which are of the greatest importance in the raw vegetable material), cannot easily be given without botanical aid. But for what purpose are botanical gardens formed, at great expense, in our colonies (for it is of them chiefly we speak,) but to afford assistance by the knowledge and experience of their superintendents in such cases? Government gardens are established at the Cape of Good Hope, Natal, Mauritius, Sydney, Victoria, Tasmania, Trinadad, Ceylon; but we do not find that any of these have been called upon by their respective governments to lend their powerful aid in sending contributions to the World's Exhibition of 1855. It is true, some of the gentlemen

attached to these establishments have volunteered their services, and in Jamaica, the garden curator seems to have gone hand in hand with the gentlemen charged with the Commission, and the result is very apparent in the correct names of the objects transmitted; while in other colonies, where there are no public botanic gardens, men of science have volunteered their services, to their own high honour and to the great advantage of the contributions. And exactly proportioned to the assistance of such men is the value of the objects sent and the amount of information accompanying them, as is clearly seen by the collections of India, Jamaica, British Guiana, Ceylon, New South Wales, Van Diemen's Land, Canada, Cape of Good Hope, and some other countries of minor importance:—but this is no reason why the botanic gardens should not be made more effective and more subservient to the promotion of the best and commercial interests of the colonies.*

Progress of Practical Botany in Britain

Economic or practical botany has made rapid strides of late years, and much of this is due to the great and liberal encouragement given by an enlightened government to the Royal Botanic Gardens and Economic Museum of Kew; and if our colonial botanic gardens were, each in its respective sphere, required to render similar services to those for whose benefit it was intended, our future "Exhibitions of the Industry of all Nations," would no longer have to complain of receiving bad and imperfect samples, or unnamed or incorrectly named ones; but, along with the correct local and scientific names and perfect samples, there would be remarks on the properties and uses, which could not fail to be of the greatest importance to our colonies and to the commercial world at large. Let but the example now set by Jamaica, as noticed at p. 53, be followed by other colonies, and the advantage will soon be experienced.

* There are two wants that were sensibly felt at the Great Exhibition at Paris, the one by the commercial party, who took a deep interest in what is at the present day a subject of no small importance, viz., the means of extracting fibre *cheaply* and *expeditiously* from plants, upon a small as well as a large scale, and which, I believe, notwithstanding all the announcements and all the promises of machinery for the purpose made at the Great Exhibition, is still a desideratum: the other, affected my brother jurors and myself while on duty in Paris, and still concerns me in connexion with the continued influx of objects, new and old, to the Museum of Economic Botany in the Royal Gardens of Kew, viz., the want of competent persons to test or analyse the various *raw products* from different parts of the world, that may promise to be possessed of useful properties, gums, resins, drugs, dye-stuffs, woods, fibres, &c., &c. Here the services of the chemist, the artisan, the manufacturer, as the thing may be, are required; and for want of these the product is put aside as useless. Offers of services are, indeed, not unfrequently tendered; but they generally end in disappointment, for it is a duty of no small labour and responsibility, and which deserves to be pecuniarily rewarded.

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much promoted by the Museum at Kew.

In respect to the Museum of Kew, now mentioned, it is an establishment which cannot but have a powerful influence on the object of this Report, which is to extend our knowledge and the resources of the products of the Vegetable Kingdom throughout the world; and as the Commissioners of the "Second Report for the Exhibition of 1851" (pp. 26, 27), have done this Museum the honour of noticing it with much favour, and have therein published an extract from the Director's Report for the years 1852–3, which was prepared or Parliament, I conclude my present communication on the Great Paris Exhibition with an extract from the Director's latest Report, namely, for the year 1855:—

"The formation of our present Museum of Economic Botany only dates from 1848. The building affords 6,000 square feet of glazed cabinets for the deposit of those vegetable products that are either eminently curious or in anywise serviceable to mankind. It is consequently of the highest importance, if simply for instructional purposes, and essential to a great commercial country, as must be evident to any person who reflects on the innumerable ways in which the vegetable kingdom ministers to the wants of the human race. The ship-builder, the carpenter, the cabinet-maker, the general merchant, the manufacturer, the weaver, the physician, the druggist, the dyer, the oil and colourman, &c. &c., will here find, systematically arranged, the several objects in which they are interested, accompanied by their correct appellations, the countries whence they come, and the names of the plants from which they are procured. Till this collection, and the correspondence which it entailed, determined these points, many had been entirely or chiefly unknown as regarded their origin or native country; and it is indubitable that every year more and more information will be elicited on points of no slight importance to a great mercantile country. So valuable and extensive a collection required a cheap and popular guide book, similar in size and plan to that for the Gardens; and one, with many illustrations, has consequently been published during the year just expired.* The Museum had already become, even before the close of 1854, inconveniently crowded by the accession of new contributions, and a considerable amount of them had to be temporarily accommodated in the temples and in sheds. A vote for an additional Museum was, therefore, submitted to and sanctioned by Parliament, and it has been

* Previous to this separate publication, the "Guide to the *Museum*" was included in the "Guide to the Royal *Gardens*," which has gone through 14 editions, each of 3,000 copies in eight years' time, to say nothing of the numerous spurious guides sold outside the Garden gates.

happily so far carried out that at the moment of preparing this Report the walls are erected, and the roof will, in a few weeks, be covered in. This structure is destined to give further accommodation to the extent of 13,000 square feet of mural glazed cabinets. And it is in every respect fortunate that the building is so far advanced; for an additional opportunity of acquiring valuable collections was afforded during last summer, when I was summoned by the French Imperial Commissioner to take an active part in the Jury of the Second Class at the Great Paris Exhibition. That Class, mainly relating to vegetable products, offered the very objects most requisite to enrich our collection. A grant of 200*l.* was accordingly obtained from the Treasury, to be expended in procuring such articles as were most important for the Kew Museum; while the President of the Board of Trade liberally offered an equal sum. Thus provided, and further assisted by the several officers of the Science and Art Department of the Board of Trade, then in Paris, and enriched by numerous donations from many exhibitors, forty-eight large cases were transmitted to Kew. They contain Vegetable Products, many of them very rare and valuable, from Algeria, Australia, Austria, the East Indies, France, the Grand Duchy of Hesse, Jamaica, Mauritius, Norway, Prussia, Sardinia, Sweden, Tuscany, the United States, Tasmania, Victoria, Wurtemberg, &c., &c. All have arrived in safety, and their contents will go far towards filling up the surplus space in the new Museum.

The Kew Museum being copied elsewhere in India, Paris, &c.

"To say that this collection of vegetable products is unrivalled, is saying little, and no more than might have been asserted while the Museum was quite in its infancy, since nothing of the same instructive kind had ever been attempted. Ours is the gratification of having set the example, which is now being followed in several of our colonies (Jamaica, Demerara, Melbourne, &c.). The East India Company is forming similar Museums in London, at Calcutta, and at Madras; another has been attached to the Botanic Garden of Edinburgh; and at the moment of drawing up this Report, I observe the following paragraph in the Liverpool "Daily Post:"—'A Museum of applied Science is recently founded, in connexion with the Royal Institution of this town. It contains already about 600 specimens, many of great value; and as it has commenced with the vegetable substances, we purpose to follow out the plan which has afforded so much satisfaction and instruction at the Museum of the Royal Gardens of Kew.' A small, but well-arranged, series of similar objects was formed, towards the close of the Paris Exhibition, by order of his

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Imperial Highness the Prince Napoleon; and we are likely to have a powerful but honourable rival in the Museum of the Jardin des Plantes at Paris. There, indeed, an unexampled collection of woods, and other products connected with physiology and pure botany, has long been deposited, but with no approach to an Economic Museum, till now, when donations and purchases, made at the close of the Great Paris Exhibition, will lay the foundation of one there on a most extensive scale."

I have, &c.

W. J. Hooker, K.H., and Knt. Bachel., F.R.S.,
and Director of the Royal Gardens of Kew.

On Indian and Colonial Products, useful as Food and for Manufactures. — By J. Forbes Royle, M.D., F.R.S., &c., Professor of Materia Medica and Therapeutics, King's College, London.

To the Right Hon. the Lord Stanley of Alderley,
President of the Board of Trade.

My Lord,

As your Lordship thought it desirable that I, as well as others of the Jurors, should make a report on such subjects as we were engaged in examining at l'Exposition Universelle held at Paris in 1855, I have the honour of submitting the following observations on subjects which appear to me of general interest. I could have wished that the desire had reached me while occupied in the duties of my Jury, as many things might then have been noted, while passing through every part of the Exhibition, which would have formed materials for a suitable report; especially as most of the subjects treated of in my own Jury were more of a professional than of a general nature. My duties as a juror of Class XII. were, moreover, performed in conjunction with the charge of the great East Indian collection, which occupied so large a space both in the Annexe and in the Palais de l'Industrie. As my time was necessarily much occupied, not only in arranging but in giving information respecting the contents of this department, my report will be confined to India or the raw products of the Colonies, as this is a subject which I have long made a special object of study, and which I also attended to in the Exhibition of 1851. Raw products were then included in Class IV., of which I was a Juror; and many of these, indeed all such as are employed in medicine as well as in the arts, were included in Class XII. of the late Exhibition.

Arrangement of observations.

The first consideration in making observations, is the order in which they should be arranged. The most obvious is that of the Exhibition itself; but as that has ceased, and the object of the present Report is to treat of such things as appear to be of general interest, it does not appear necessary to adhere to an arrangement, when doing so is productive of inconvenience. This is the case with one part of the arrangements of the classification of 1855, as in the separation of cultivated from uncultivated products, whether animal or vegetable. Because, when we have to deal with the products of the whole

Dr. Royle on Indian and Colonial Products, &c.

world, we find, that not only is the same substance obtained by cultivation in one country, and from the profuse bounty of nature in another, but we find that this is the case even in different parts of the same country.

As these various products are valuable to man, either for immediate or for manufacturing use, on account of their respective properties, so it is preferable to arrange them according to their nature or their chief proximate principles. For it is, in most cases, evidently immaterial whether a wood or a fibre, a dye or a drug, is obtained from a wild or a cultivated plant, or even whether a silk is spun by a wild or a cultivated silkworm. Therefore, it is at all events better to treat of them together, than as distinct objects of study. A classification according to the properties of objects, moreover, is

According to Exhibition of 1851,

not only good, but having been promulgated from the Exhibition of 1851, has become known in all parts of the world: indeed, several of the collections made for the Exhibition of 1855 were sent arranged according to the classification of 1851.

Before proceeding to notice individual articles or groups of such as are similar in nature, we may make one general observation respecting the collections themselves. This is respecting the greatly increased attention which is paid throughout the world to the collection and exhibition of the various substances now usually classed under the head of

Attention paid to Raw Products.

Raw Products, even though some of them have undergone a process of manufacture, as for instance, sugar, indigo, tea, &c. Of these collections, those from the British dependencies were especially conspicuous, as from India, Australia, Guiana, Ceylon, while Canada was remarkable for its timbers and agricultural collection. But Algeria and the French and the Dutch colonies also exhibited very excellent collections. In some a very great variety of objects were shown, proving the great extent of the natural riches of the country illustrated. Others displayed a great number of specimens of the same article, showing the attention paid to its cultivation by various colonists. Some again displayed only small quantities of each article, even when these formed considerable articles of commerce. Others, on the contrary, exhibited comparatively large specimens of what were only experimental cultures. This might and did deceive, not only casual observers, but even some writers, with respect to the comparative abundance of articles so differently exhibited. This was more particularly the case when they did not pay attention to the very important fact, whether the space allotted was in proportion to the quantities of things which a country had to exhibit, or only so much as could be spared. It would, for instance, have

been easy for India to have covered double the space that was allotted, even without the contents of numerous boxes which had been sent from India for the Exhibition, and left in London or elsewhere on account of the anticipated want of space.

Should be connected with Natural History.

We may observe also, that it is very desirable that the raw products of different countries should be connected as much as possible with the plants or animals which yield them; and the scientific names of these given in connexion with the vernacular names of their products. This not only because the former are everywhere the same, and each only applicable to particular species, while the latter may and do vary in every district. But it is also more satisfactory, and most useful, indeed essentially necessary, in order to trace out any information which may have been published respecting particular articles, and to compare them with similar products from other countries, or with those which may already be in use. In order further to attract the notice of manufacturers, information should, as much as possible, be added respecting the uses, the quantities procurable, and the prices of new articles.

The establishment of trade and of local museums will greatly conduce to the collection of such information. As an effect of the Exhibition of 1851, we may adduce, as not much known, the establishment of the Museum in Madras, which in two or three years has collected about 30,000 specimens for exhibition, as shown in a well-arranged and printed catalogue. Indeed, it may be added, that six subordinate museums have been established within the limits of the Madras Presidency during the last year, and a central one in Bombay.

For the collection of articles, and for methodising such information, it is necessary to give ample notice to distant countries previous to any proposed Exhibition; otherwise new things with strange names, when presented to Jurors and manufacturers, are apt to be neglected, in place of being sought out and inquired about, not only for experiment, but as suitable for different purposes.

Mineral Substances.

Rocks and minerals will necessarily be noticed by other Jurors, and due justice will be done, as well to the iron and steel works of England as contrasted with those of the Continent, as to the gold of Australia, and of California, and to the much praised Onyx Africaine of Algeria. But as there were some mineral substances exhibited in the Indian department,

which, though small in size, were yet of general interest, and as little is generally known respecting them, some observations may be made concerning the coal of India; also respecting its graphite, petroleum, tin.

Indian Coal-Fields.

Indian coal-fields.

The Indian coal-fields are probably equal in extent and in the number and thickness of the beds to any in the world. These beds extend over nearly 30° of longitude, from the east to the west of the Valley of Assam, and along the Silhet mountains, between 27° and 25° of north latitude. From thence the coal has a southern development, as in Arracan and the Tenasserim provinces, and their several islands, as far south as 11° of north latitude. If we return again to the north, we find coal beds near Rajmahal, on the western bank of the Ganges, in 25° of north latitude. Thence we may follow them through the Burdwan and Ramghur formations, along the Nerbudda as far as Hooseinabad, with a southern extension into Cuttack and Central India to about 21° of north latitude. Finally, on the extreme west we have the small coal formation of Cutch, and other trifling deposits along the Indus.

This coal varies in quality as in other formations. It has sometimes been rather hastily asserted that it is all of inferior quality, because some that was superficial was found to be so. The principal coal-pits have had the advantage of having been examined by an experienced geologist, the late Mr. Williams, and some of them subsequently by Mr. Oldham, the present geological surveyor. The former observed, as others had previously done, the anomalous position of this coal formation, resting as it does upon the older rocks; but like them, he was unable to find any organic remains by which the age of this formation could be determined, though in other respects he considered it analogous to the coal formation of England. But subsequent observation, and the finding of some fossils in the central part of India, makes it probable that the age of the coal is subsequent to that of the Oolitic formation. Mr. Williams observes, that it has been ascertained that the coal-field entombed in the Damoodah Valley has a developed thickness of at least eleven thousand feet. It is a portion of this coal-field which has been worked for the supply of Calcutta and the steam navigation of the Ganges.

Age of coal.

Thickness of formation.

Burdwan coal.

The principal beds have been called the Burdwan coal-field, distant about 140 miles from Calcutta. The only difficulty experienced in obtaining an abundant supply has been from the irregularities of navigation of the Damoodah river. The railway, which passes directly along the coal-field, will, however, obviate this, as the railway company has

engaged to carry 75,000 tons of coal per annum from the collieries to Calcutta for the next two years.

This coal has for many years been used in considerable quantities in Calcutta; much of it is like brown coal, and is chiefly laminar in structure, has a specific gravity of between 1·3 and 1·4, leaves a larger proportion of ash than English coal, but gives out more gaseous matter. It is well adapted for blaze fires, less so far coking and close furnaces. It has been much employed in the steam engines established in Bengal, as well as in river navigation. Mr. Williams was of opinion that the best description of coal would be found here. The expenditure of Burdwan coal for the year 1850 was calculated to amount to 6,311,961 maunds, each of 82 lbs. The average cost of Burdwan coal in Calcutta was about five annas, English and Welsh coals being procurable for six annas a maund; but in the year from 1st May 1852 to 30th April 1853, the prices ranged from ten annas to one rupee two annas.

Other kinds.

At the Exhibition, specimens of coal were exhibited from the Ranigunje mine, from Ramghur, and also from Singrowlee. This lies directly south of Mirzapore, which is on the Ganges. As the coal is of good quality, equal to the best Burdwan, it would rapidly come into extensive use if it were not for the wild and rugged country which intervenes between the mine and the Ganges river. The mine has, however, been worked by Messrs Hamilton, of Mirzapore, and found good for steam purposes by the Ganges Steam Company.

Assam coal.

The specimens of Assam coal were not of such good quality as some which had previously been sent. As this has been thought to be the best of the Indian coals, and one which yields very fairly good coke, numerous attempts have been made to obtain a supply from this locality, but the hilly nature of the country throws considerable impediments to the transport.

Arracan coal, &c.

The specimens of Arracan coal are interesting, as being near the sea, and as placed between the coal-fields of Assam and those found on the Tenasserim coast; hence these also have their chief interest from the ready access to them by sea. The coal, called of Arracan, has been found at Ramree and at Sandoway, but the most promising site is at a place called Hoong, near the head of a river which falls into the Sandoway Channel. Of the Tenasserim sites of coal, some are in the Mergui district on the Tenasserim river. That situated near Thian Khan is important, both from its extent and from the superior quality of the coal. It is, moreover, easily accessible for the supply of the Straits and of Ceylon, and may therefore, like the coal of Borneo, be considered important for the steam navigation of the Indian seas.

Petroleum or Earth Oil.

Earth oil.

Specimens of this very useful—but comparatively little known, as an Indian—product, were sent from two or three places, as Assam, Arracan, and Rangoon, where the supply is abundant, the price moderate, and the access to some of them, even by sea, easy. The supply is most abundant along the banks of the Irrawaddy; indeed Rangoon, or Ranangoong is said to be named from words signifying Earth oil creek, from the numerous wells of petroleum in its neighbourhood, and which are also found higher up the river. The produce of some of the wells is said to be about 800 hogsheads annually; numerous boats are constantly employed in conveying it away, as the natives use it for various purposes. It is of a dingy green colour, of a viscid consistence, sometimes more fluid. The greater portion (80 per cent.) of this earth-oil consists of a very fine naphtha, which is separated by distillation, leaving bituminous residue, which could be used for the purposes of asphalt. Drs. Christison and Gregory obtained from it many of the same principles as are separated from tar. Hence it has been inferred, that this petroleum is the product of the destructive distillation of vegetable matter.

Abundance.

Uses.

It is used by the natives for lamps, and boiled with resinous matter, it serves for painting the timber of houses, and for paying the bottoms of boats, which it preserves from decay and vermin. A not unimportant use, especially in countries where the houses are built on posts and always liable to be flooded. So in the West Indies, Barbadoes tar is said to be used for paying ships, and saving them from the Borer or Teredo. The distilled naphtha forming an excellent solvent for caoutchouc, might be employed in the country itself for dissolving the caoutchouc which is produced there, and thus be used for excluding rain from tents, and for the coverings of carts and boxes. It might also be employed for anti-attrition purposes, and become an important article of commerce.

Graphite or Plumbago.

Graphite or blacklead.

Since the diminution or nearly cessation of the supply of the best graphite, or what is called blacklead, we have been supplied with good pencils chiefly in consequence of Mr. Brockedon's invention, of obtaining compact graphite from great mechanical compression of pure powdered graphite. So Mr. Brodie's discovery of the method of purifying graphite by chemical agency promises to be of great utility, in enabling us to make use of the less pure specimens, and thus of greatly extending their employment. Some of Mr. Brodie's experi-

ments were made upon impure graphite which was produced in India, chiefly in the southern and maritime province of Travancore. These specimens are in nodules, extremely soft, but brilliant, and very much like the Ceylon graphite, which is sold from 8*l.* to 10*l.* per ton. The purer specimens of the Travancore graphite would rank with these, but as all impurity diminishes its value, care should be taken in picking out the best pieces, such as those free from the admixture of quartz or of iron ore. As Trevandrum, near which the plumbago is found, is near to the sea, and also to a port like Cochin, little expense need be incurred in sending this article to market, which can, moreover, come as ballast.

Some graphite was also exhibited from the distant province of Kemaon in the Himalayas. This also had the disadvantage of being mixed with quartz and iron ore; but from the internal purity of some of the nodules, and the compact nature of the mineral, it is probable that some of the best quality of graphite may yet be found in a locality where the supply is abundant: and as the best graphite sells for 30*s.* a pound, such would readily pay all expenses of carriage from even so distant a locality.

Rock Salt, Kaolin, Corundum.

Rock salt of Punjab.

An interesting series of specimens in the Indian collection, though they arrived in a broken state, was formed of numerous objects turned out of the rock salt of the salt range of the Punjab; so also were some beautifully formed and large cubical crystals, formed of sea salt from the west of India.

Kaolin and Corundum of Madras.

The various specimens of kaolin may become articles of export from the Madras Presidency, as they seem well calculated for the formation of the best kinds of pottery and porcelain. So also the corundum, or koorund of the natives, which is found in so many places in the rock formations of the Madras Presidency, might be exported in large quantities, and would be greatly in demand as a substitute for the emery of the Levant, for the polishing of steel, &c., if the natives could be induced to collect only the pure specimens, and avoid intermixing them with others. The natives themselves employ it largely for forming artificial grindstones, also for polishing granite, agates, and other hard minerals, as at Cambay, &c.

Pebbles.

The pebbles of the Godavery, of the Soane, and of Cambay are perhaps too abundant elsewhere to be an object of desire from such great distances.

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Metals.

The natives of India have long been famous for a knowledge of the mode of producing steel of superior quality, as well as for various metallurgical compounds. Among these, the natives of some parts of India, as of Bellary and of Tanjore, are famous for the manufacture of bells; those which were exhibited were much admired by good judges, for the purity and clearness of their tone.

Production of iron in India.

The production of good iron and steel is one of the most important objects for the improvement and development of all the other resources of a country, and India has long been famous for the production of both. The natives, notwithstanding the great abundance of iron ores, have no methods of producing either iron or steel in large quantities, such as are required in the present day, either for the fabrication of arms or for the rails and machinery of railways. Large sums have been expended for the establishment of the ironworks at Porto Novo, and considerable difficulties were experienced for many years in making them profitable. Of late years, Mr. Williams and Mr. Oldham, both employed on the geological survey, have each written, the former in favour of, and the latter against the probability of the profitable manufacture of iron in India. But in this case, as in others, everything depends upon the greater or less vicinity to each other of the ore, the flux, and the fuel, and which, though far apart in one situation, may be in juxta-position in another, and also near water carriage. Therefore, what is unprofitable in one place would be the reverse in another, and this the process of discovery will, I believe, shortly demonstrate.

Tin.

Tin is an important product of eastern regions, as it is largely employed by the natives of India and others in various metallurgical compounds, for which they have long been famous. It is interesting also because it forms an ingredient in the composition of the most ancient kind of arms, in which it was employed for hardening copper. It has been inferred by some authors, that this tin must have been obtained from Cornwall, notwithstanding that the deposit of tin is very abundant in the east, as in Borneo and other islands, in the Malayan peninsula, and during the last few years it has been found in the Tenasserim provinces. The produce of the former localities is largely imported into Europe, that of the Tenasserim provinces has also of late begun to be exported. Specimens of stream tin of the first and second washings, and of smelted tin, were sent to the

Exhibition from Moulmain; the latter in flat tablets. The price of tin at Mergui is from 70 to 80 rupees the viss of 365 lbs. In the year 1843, it was calculated that it could be sent to England for about 38*s.*, when the price here was 46*s.* per cwt.; but in an actual experiment it was found that the metal cost 47*s.* 9*d.*, while the charges amounted to 20*s.* 7*d.*, making in all 68*s.* 4*d.* per cwt. It sold only for 56*s.*, entailing a loss of 12*s.* 4*d.* per cwt. But this was at a time when tin was at a very depressed price, as it usually sold for 72*s.*, and is now worth about 130*s.* per cwt.

Precious metals imported into India.

The continued import for ages into India of the precious metals has been a subject of serious inquiry to political economists. The enormous quantities of gold from California and Australia have diverted general attention from the former sources of supply of this metal, though some of these still continue to yield their average produce. But others are exhausted, or continue to yield such small quantities, as to pay but scantily the washers of gold. Among the poorly remunerated, though working on their own account, those of India may be included. But the sites are extremely numerous, both along the Malabar Coast and the foot of the Himalayas, as well as in Assam, where the sands are washed for gold; and this has in some instances been traced to its quartzose matrix in the hills from which the rivers proceed in Southern India. Silver is nowhere obtained, but it has been stated that some of the galena found in the Himalayas contains some silver intermixed with the lead. Yet the consumption is enormous of both gold and silver in India, as indicated by the continual imports. It has been supposed by some that this is to be ascribed chiefly to the practice of hoarding these metals; latterly it has been suggested, that the increased cultivation of the land in many districts requires an increased expenditure of capital. Both have no doubt considerable influence. But less importance than it appears to me to deserve, has been attached to the practice of the natives of the east loading their women and children with gold and silver ornaments. The love for these is so great throughout the land, that when the superior kinds cannot be afforded, imitations are substituted, or such as are made of less valuable materials, such as glass, horn, wood, and even of platted straw. Therefore, when the people generally increase in the means for supplying the necessaries of life, a portion of their superfluity is certain to be expended in purchasing silver ornaments for their families; of which such numbers are worn by some females, as anklets, armlets, bracelets, necklaces, rings, and head ornaments of various kinds. Silver wire, moreover, is used for various tissues, as well as when gilded

for the various fabrics of gold and silk. It would be an interesting subject for careful inquirers in the neighbourhood of the larger towns, to endeavour to ascertain the quantity of silver expended for such purposes. But this would give only an approximation, for the Sonar or worker in gold and silver is to be found in all the larger villages throughout the length and breadth of the Indian empire.

Agricultural Products.

Though the subject of agriculture will necessarily be treated of by a Juror well qualified for the task, we may yet observe, that it is hardly possible to have any classification that is perfectly suitable for an exhibition of the products of the whole world. Thus in the present instance, what are known as imports only in European countries are the principal objects of the agriculture of Tropical regions, though excluded from the class of agriculture in exhibitions held in Europe. In the following observations on the agricultural products of such regions, I propose to refer almost entirely to articles of food, as it appears to me that greatly increased quantities may be obtained from warmer regions, which are well suited to European use, and might therefore be beneficially imported.

Rice.

Rice, the principal product of Tropical regions, has come to be an ingredient of European diet, though, owing to prejudices, not to the extent that is desirable, in order to give relief in times of scarcity. Because much larger quantities are produced in climates favourable to its production, such as Bengal, Arracan, and other parts of the east side of the Bay of Bengal, than are required for the subsistence of their inhabitants. Much remains for export, and hence the large quantities exported to different parts of Asia as well as to Europe. From Arracan many varieties of rice were sent to the Exhibition. The exports from Calcutta in 1855 amounted to 27,88,534 maunds, being an increase of about 140 per cent. on the previous year.

Diet of natives of India.

By many it is supposed that the natives of some of these warm countries, especially of India, live almost entirely upon rice. Nothing is more fallacious, for it is only in a portion of such countries that the natives live upon rice as the chief portion of their diet; but even in these, considerable additions are made of ghee, or melted butter, as well as of various pulses, which, like peas and other legumes, supply some of the flesh-producing principle of chemists as a necessary ingredient in all diet. Besides these, many of the millets, as well as various vegetables, are employed. The durra of the Arabs,

the jowar of India (Sorghum vulgare), resembles maize or Indian corn, and is probably as much used as an article of diet in Asia as maize is in America. The straw, or rather stems, being cut into small pieces, are much employed as fodder for cattle. The grain, however, though smaller, is also softer, and very apt to be attacked by the weevil, which renders it difficult of transport to distant countries. A variety of this plant, or a distinct species of the same genus, which has been called *Sorghum saccharatum*, has lately attracted much attention for the production of sugar. Sorghum.

In no instance is the benefit accruing from the interchange of plants of different countries more conspicuous than in the case of rice introduced from Asia into America, from whence some of the finest varieties now come, under the name of Carolina rice; while maize, widely diffused, though probably nowhere extensively cultivated in Asia, had the finest specimens in the Exhibition sent from Australia.

Many of the smaller grains, known under the general name of millets, but differing much from each other, form a good deal of the food of the poorer class of the natives of India, and are usually very cheap in price. Though not accepted as suitable for the food of even the poorest in this country, some of the millets do form part of the diet of the people in different parts of Europe. They have the disadvantage of being small in size, yet their chemical constituents are very similar to those of the larger grains, and as they are harder externally, they are not so apt to be injured by the weevil, and may therefore be exported with greater facility. As they can be cultivated in the poorer soils of the East, they might be greatly increased in quantity for exportation, if required for the feeding of animals, and thus serve to save the larger cereals for the use of man. Besides the larger cereals and millets, many pulses, produced by species of Cajanus, of Phaseolus, and of Dolichos, form ordinary articles of Indian diet. They are wholesome and nutritious, and are eaten either boiled with rice or stewed and flavoured in various ways, so as to form a palatable addition either to their boiled rice or to their wheaten cakes. These would form an excellent substitute, as has been proved by experience, for peas, either in the form of the lentil soup of the French, or be used like their haricots, or form an addition to stews. The chief of these are indeed known in the Mediterranean region, and used as articles of diet; for instance, Cajanus indicus, sometimes called pigeon pea in England, and which, under the name of dall, forms one of the favourite pulses of the East: Cicer arietinum, or chick pea, the gram of the Bengal Presidency, upon which horses are fed instead of upon oats, and Millets. Pulses.

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sheep fattened for the table; it is produced of a fine quality in Algeria and the south of Europe. In the Madras Presidency, the name Gram is applied to the pulse of *Kooltee*, or Dolichos uniflorus. Among the most commonly used of the pulses, are species of Phaseolus, known by the names of moong, mash, oorud, while others are produced by species of Dolichos, which may be called the haricots of India. A common kind of pea and the lentil are also much cultivated. Some of these seem well worthy of introduction into the West Indies and into Guiana, as suited to the climate, easily cultivated, and increasing the supply of food for the labouring population. Some of the Coolies from the East would especially appreciate the introduction of their favourite pulses.

Wheat.

Wheat, however, is so much the principal grain, and its chemical constituents are of so general a nature, that all others are by some accounted to be of so little value as to be unworthy of notice. Indeed, the condition of those is inferred to be of a degraded nature who make use of other cereals, even as parts of a mixed diet. Yet, though wheat is the great object of culture throughout the European continent, the finest specimens of wheat seen at the Exhibition were grown beyond the bounds of Europe. As in the Exhibition of 1851, so in that of 1855, Australian wheat was shown to be of a superior quality, and it is well known that it always brings a high price in the English market; but on the late occasion, a fine collection of wheats was shown from the French colony of Algeria, proving how much better it is adapted for such culture than for some of those of the Tropics which the colonists have attempted. Many of the finest specimens are of the variety known as hard wheats, which are so largely also exported from the Black Sea; but these, though nutritious, are objected to by millers on account of their hardness, as this renders them difficult to be ground. But still, from the large proportion of gluten which they contain, they are desirable for food, inasmuch as they are proportionally more nutritious, and are especially well adapted for the making of macaroni and of vermicelli. They are, moreover, less readily destroyed by the weevil, and are thus more easy of transport.

From Australia.

From Algeria.

From India.

Few would look to India as a wheat country, and yet some samples of excellent quality, grown near the banks of the Nerbudda, were shown in the late Exhibition, as they were in that of 1851. Considerable quantities, moreover, have been imported into this country, and sold in the markets of London and Liverpool during the last year, as in the year 1848, when prices were also high. Wheat is cultivated along the valley of the Ganges, and all across India to its western coast, as

well as in the provinces of Sindh and in the Punjab. In the Bengal Presidency, the cheapest is produced in the lower provinces, from the facility of irrigation, but dearer in the north-western provinces, from the greater expense of irrigation in the cold or dry weather cultivation. The average annual price in Calcutta was calculated to be 1^{r} 13^{a} 4^{p}, or 3*s.* 6*d.* for a maund of 82·28 lbs., or about 21*s.* per quarter; but with freight and other charges, it could not be landed in England for less than 50*s.* a quarter. From Broach, on the west of India, it was calculated it might be sent for 40*s.*, but in an actual experiment it cost more. It is, however, an abundant and cheap produce of Sindh. About 90,000 qrs. of Indian wheat have been imported into Great Britain during the last year. The rapid increase which takes place in the exports of wheat from Calcutta, when prices rise in Europe, is shown by the following table. In 1851–52 and 1852–53 the exports were only to Asiatic ports and none to Europe; in the subsequent years, exports took place to Great Britain and France;

Cost.

Imports into Great Britain.

1852–53.	1853–54.	1854–55.	May 1855 to Jan. 7, 1856.
259,489	252,314	462,078	934,178 maunds.

The last sum is equal to 185,000 qrs., and took place in nine months, and may therefore be considered as tripled at once. *Vide* "Friend of India."

The grain is dearest in September and October, or about the period of sowing the seed, and cheapest in March, when the crop has just been harvested. The early period of this grain ripening in India is of considerable importance, as noticed by Colonel Sykes, if we look to a supply in seasons of scarcity, as both wheat and barley, being ripe in many places in February, might reach this country even by the route of the Cape of Good Hope before the English grains were ripe.

Price at different months.

The excellent quality of some of this Indian wheat is well worthy of attention. Of some grown along the banks of the Nerbuddah, one variety, a soft white wheat, weighed 64lbs. to the bushel, and was valued a few shillings above the best wheat in the English market. Another, a hard wheat, weighed 63½ lbs. to the bushel, and was valued at something less, because not so well liked by the millers; though the natives of India, who buy their own flour and bake their own bread, that is, wheaten cakes, prefer the hard to the soft wheat, because they consider it more nourishing. In this they are probably right, as good chemical reasons can be given for their preference.

Some Indian wheat excellent in quality.

Early ripening.

The early ripening of this Indian wheat, like that of Algeria, makes it an important resource, not only in years of scarcity even by the route round the Cape of Good Hope, but if there was any probability of a route being opened by the Red Sea, either by canal or railway, large quantities of the finest wheat might be readily and even cheaply obtained in all years from the west of India, and thus become an ordinary quotation of early Indian wheat in English markets.

French experiments in compression of flour.

The great difficulty in the export of wheat from the East is the frequency with which it is damaged by the weevil, and it seems hardly possible to devise a suitable remedy. With respect to flour, the experiments caused to be made by His Majesty the Emperor of the French seem to prove that it may be conveyed to great distances, and retain all its qualities unimpaired for a long period of time. In these experiments flour was compressed by an hydraulic power of about 300,000 kilogrammes (300 tons), and a reduction in its bulk was effected of rather more than 24 per cent. After this compression the flour was found to retain all its qualities. Some of it was fastened up in boxes, and examined six months, and even two years afterwards, and compared with flour which had not been compressed, but kept an equally long time. It was found that the pressed flour had in every case an advantage over the other. Experiments in baking proved the same thing. Some American experiments have also proved the great advantage of compressing flour to enable it to travel well: a modification of the method might perhaps be applied, though with difficulty, to the entire wheat.

Fecula or Starch, &c.

The other vegetable products may probably be most fitly noticed under the head of their respective proximate principles, though many of them are as much the objects of agricultural industry in different countries, as those which have been noticed under that special head. Some of these are also like them employed for food.

Fecula as an article of diet.

The fecula of chemists is in one form very well known by the name of starch, and in another by that of arrowroot: and as this was at one time thought of only as diet for the sick, so was the other only for stiffening calico and linen. But it is so abundant a secretion of and stored up in different parts of plants, (as the seeds, roots, and stems,) that the sources are abundant of an extended supply, and it might be included among the regular articles of diet, just as the Malays live chiefly upon sago meal, and the South Americans upon cassava bread. The less pure kinds are required for starch,

for calico-printing, and for other manufacturing purposes, in which damaged flour is now regularly employed.

Fecula is usually intermixed in plants with other principles, some of these even of an acrid nature; but in consequence of its characteristic property of being insoluble in cold, though easily dissolved in boiling water, it is easily and cheaply separated from other substances by suspension in water, straining, and subsequent subsidence. While in other cases, we find the acrid principle is destroyed by the action of heat, as in the case of cassava bread, and in a less degree in the potato.

Sago meal is an abundant produce of Tropical regions, as of the Malayan peninsula, and of the numerous Indian islands. Some excellent specimens were sent from Singapore. It is a principal article of food with the Malayan population. The import into this country of sago meal has greatly increased, and much of it is employed in manufactures. The inferior kinds of sago have been made use of for feeding poultry and pigs. But as the trees take several years to attain perfection, and must be cut down before the fecula can be washed out of their split stems, we cannot expect any great extension of the culture. But one of these, the *Arenga saccharifera*, can be successfully cultivated on the low coasts near the sea, and abounds in sap, which can be used as palm wine, or converted into sugar; the older trees when cut down yielding sago. They yield, in addition, the strong and durable fibre known by the names of Ejoo or Gomuto fibre, and sometimes as "Vegetable bristle," in the English market. *Sagus lævis*, which is remarkable for yielding the fecula which is afterwards granulated into sago, may be planted on the very edges of the maritime marshes which abound in the same localities. It is noted among palms for throwing up young plants around it, in the same way that the plantain does, and therefore affords great advantages for cultivation in such localities.

Sago.

Ordinary sources of.

Sago-like meal is yielded by some of the other palms, such as *Caryota urens*, the *Kittul* of Ceylon, which also yields a black fibre like that of the Ejoo, useful for the same purposes. Some species of Phœnix yield a similar farina. Of this, specimens were sent to the Exhibition, being used as an article of diet in times of scarcity in India. So the plantain, which abounds in all the tropical parts of the world, yields with little culture a very large return per acre, and a superfluity of nutritious food. This may either be preserved in a dried state, of which good samples were displayed from Ceylon, and some specimens that had been kept for several years from India. A meal may, moreover, be prepared from

Other sources.

Plantain meal.

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it. In South America both are objects of attention and of internal trade; the flour is either cooked for food or made into biscuits. It seems desirable that this should also be extensively practised in eastern countries, where the plantain is equally abundant, and where its refuse stem might be made to yield a profitable return in the form of fibre for paper-making, or for ordinary cordage. Some fine specimens of fibre were shown from India, as well as from Guiana; and the paper made from plantain-fibre was among the toughest of all the new kinds of paper. The fruit is preserved in some parts of India, and specimens of meal have been sent from different parts.

Cassava flour and tapioca.

The Cassava is another plant of which the yield per acre is large, and which in South America affords so large a portion of the food of its inhabitants in the form of cassava bread, or as tapioca, which is the cassava flour granulated. There are two varieties of this plant, one the sweet, and the other the bitter cassava: it is the latter which is chiefly employed for obtaining the above flour; and though it has been introduced into eastern countries, and cassava flour and tapioca prepared from the plants there cultivated, it seems to be nowhere so extensively cultivated as it might be.

Arrowroot.

Arrowroot, a name once commonly applied to the fecula of a plant which had arrow-shaped leaves, is now used as a general designation for the fecula obtained from a variety of plants. The arrowroot of the West Indies is now also cultivated in the East, and some fine specimens of the fecula were sent from India. Though this kind is that much preferred, there are many others, as, for instance, the Cannas and Tous les Mois of the West, and the Curcumas of the East, which yield fecula, which for all essential and nutritive properties is equally good. As the microscope enables us at all times to distinguish one kind of fecula from another, we need never be deceived about what we are employing. Some of these Curcumas yield such fecula in all parts of India, and about 7,000 or 8,000 maunds are annually exported from the Malabar Coast.

A great variety of other so-called tubers, as yams, sweet potatoes, all yield fecula, and some others which are not useful for diet. The Igname de Chine, a variety of Dioscorea Batatas, is being cultivated in France, as a substitute for the potato.

Sugar.

Sugar, desirable to extend its supply.

The production of sugar has long been a principal object of attention not only in the British but also in other colonies, and the result has been a great reduction in price, so as to

bring it within the reach of a much larger circle of consumers. But this has not yet attained such extension as to obviate the great rise in price to which it has been subject during the last year, and apparently without sufficient cause. Though the surface of supply cannot be considered as confined, yet for an article of universal consumption in Europe, it is desirable to have the supply from a still more extended surface, and, if possible, from a still greater variety of plants, as the failure of the crop of one is not likely to occur at the same time with another in a distant country. The supply may moreover be increased by improved methods of cultivation and of manufacture. Though the sugar cane yields by far the largest supply of sugar both in the Old and in the New World, it has been proposed to cultivate the plant called *Sorghum saccharatum* even in India. A variety of the same plant introduced from the north of China has been proposed for cultivation in France, where beet-root sugar is so largely produced.

Palm sugar.

The Palms yield a continual supply of sugar, and without the trouble of annual culture, but then they take many years to come to perfection. The wild date tree yields much of the sugar sometimes distinguished by the name of date sugar, which is produced in Bengal and exported from Calcutta. It has been proposed to make use of the Palmyra tree, which is so abundant in many parts of the Madras Presidency, for the same purpose. Both date and palmyra sugar were among the kinds exhibited from India. The different sago palms, which abound in saccharine sap, might also be made to yield a regular supply of sugar. Some of the Gomuti sugar was sent from Singapore. An abundant and yet neglected source of sugar appears to be the Neepa or Nipa plant, which is sometimes called Nipa Palm (*Nipa fruticans*), but which belongs rather to the Screw Pines. This plant is very abundant all along the shores and creeks of the Malayan peninsula and islands, and the sap, obtained by simple tapping, yields by evaporation large grained sugar. It might form further occupation to the people of Pegu and similar places, who live near to where it grows, and who already collect its leaves for thatching.

Nipa sugar.

Improved manufacture in India.

Considerable attention is now paid in different parts of India to the improved manufacture of sugar, as at Cossipore, near Calcutta, by the Aska and the Astagram Sugar Company in the Madras Presidency, also in the north-west of India and in the Bombay Presidency. It is probable that in addition to the present increased exports, larger quantities will be obtained from that country. But the great internal

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consumption and the sudden rise in price at the ports of export, when an extra demand occurs, throw some difficulties in the way of commerce.

Tea, Coffee.

Tea in Indian and Dutch collections.

The Exhibition contained, both in the Indian and Dutch collections, very interesting specimens of tea made out of China. It was long thought that the climate required by the tea plant was of so peculiar a nature, that it could not be successfully cultivated beyond certain prescribed limits. From a careful comparison of the soil, climate, and vegetation of the portions of the Himalyan Mountains with which I was best acquainted, and such notices of the Chinese tea districts as could be obtained from the account of the Jesuits and by others who passed through or near to tea culture in China, I was of opinion, that the tea plant could be successfully cultivated in the Himalayas, and this as long since as the year 1827, as also in an essay on the subject printed in 1834, in my Himalayan Botany. Tea plants having been found in Assam, the culture and manufacture was prosecuted in that valley with the aid of imported Chinese manufacturers, at first with some difficulties, perhaps inherent in all such undertakings in new and distant situations, but at present very successfully, as a tea much in request is readily sold at good prices in the English market. Two very good specimens of this tea were sent to the Exhibition, and one from a Chinaman named Amoong, who has become a resident in Assam.

Tea culture recommended by author in Himalayas.

Culture in Assam.

Culture in Himalayas.

In addition to the culture in Assam, experiments were commenced in the north-western part of the Himalayas with seeds imported from China. When the plants had attained a sufficient age, the experiment was made of converting the leaves into tea, with the aid of Chinese manufacturers. The success which has attended the experiment was well shown by the favourable reports which have been made by skilled brokers, both in Calcutta and London, on the samples sent over. This is still more evident by some facts taken from Dr. Jameson, the present superintendent's last report.

Its success.

Extent of culture.

The plantation of Paoree, which four years ago was a mere oak and rhododendron jungle, has now 350,000 plants yielding tea, and 500,000 seedlings. The yield last year was 3,394 lbs. of tea in a plantation of less than 200 acres, and the return this year will be about 5,000 lbs. The Kaolagir plantation, which was very flourishing, yielded last year 4,112 lbs., which the return of the present year will exceed 10,000 lbs. The yield is at the rate of 70 lbs. an acre. Preparations had been made for extending the cultivation over a large tract of country, by

the 2,000,000 of seedling plants which Dr. J. has reared. He further says, the tea plant is now flourishing over four and a half degrees of latitude and eight degrees of longitude, over a tract containing upwards of 30,000 square miles of land.

Expense of culture and of manufacture.

The cultivation of the plant is not expensive, nor would the manufacture be so when once fully established, and the natives of India have learned to make the different kinds of tea under appropriate superintendence. But at present the Chinese tea manufacturers, engaged at a high salary for the whole year, are employed only for a short period, that is, during the season when the tea is actually being made. The great object to be kept in view is to induce the natives of the hills, and more especially the cultivators, to engage in the cultivation of the tea plant.

Green and black tea made from the same plant.

These experiments have determined that though there are different species of tea plant, yet that both black and green teas may be made from the same plant, and are most commonly made from the species called *Thea viridis*. Mr. Fortune, who was sent out to China by the Court of Directors of the East India Company, when the great success of the experiment warranted that every advantage should be given to it, especially settled the last point. The differences seem to depend more upon the manufacture than upon the plant. The *black* teas undergo a process of fermentation, while the leaves in the green tea manufacture are roasted without undergoing any such previous change.

Dr. Jameson calls attention to the fact that in China teas go through the final process of manipulation in the interior of the country, and in this state are purchased by the agents of the merchants, and forwarded to the sea-board towns, where the second firing, with winnowing, sifting, picking, and packing, is performed. If such a system could be introduced into the Himalayas, it would greatly encourage the natives to undertake the cultivation in different quarters.

Varieties of tea from the Himalayas.

Six varieties of green teas were exhibited from the tea nurseries established by the Indian Government in the Himalayan Mountains, and were packed in very small boxes, made in exact imitation of the tea chests made in China. Some of the teas are considered by brokers to be as good as China teas, others they call fancy teas. Dr. Jameson estimates that the tea can be sent from the Himalayas for 6*d.* per lb., and some could, no doubt, be sent at once for sale to Europe, if it were not that it brings a much higher price, that is, about five shillings a pound by being sold on the spot, that is, at the annual sales which are held at Almorah.

The following account of the sales of tea has lately appeared in an Indian newspaper, and as the extract has been

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forwarded to me by Dr. Jameson, it may be considered authentic :—

"We have been favoured with an abstract statement of the quantity of tea recently sold by auction at Almora and at Deyra, with a memo. of the number of purchasers, European and Native, their place of residence, &c. These statements are yearly becoming more interesting, and are especially so at a time when Government have offered very liberal terms to those who may be inclined to enter on a speculation bearing every promise of success, if carried out with prudence and determination.

"The number of chests of tea brought to the hammer at Almora, amounted to 908, containing lbs. 9,612 and 6 oz. Of these, 537 chests were purchased by Europeans, and 371 by Natives. One hundred and three chests were bought by Residents in the Punjab, where the new teas are especially appreciated, 96 for the North Western Provinces, 16 for Nainee Tal, and 322 for Almora and its visitors. The natives who bought were all residents of Almora or Nainee Tal. Three kinds of green tea (Gunpowder, Young Hyson, and Hyson skin,) and three kinds of black (Souchong, Pouchong, and Bohea,) were sold at Almora and fetched *per pound :*—

	High.	*Low.*	*Aver.*
Gunpowder	4 12	4 8	4 8 2
Young Hyson	4 8	1 8	2 14 5
Hyson skin	0 7	0 5	0 8 20
Souchong	2 15	1 1	2 9 11
Pouchong	1 11	0 14	1 2 10
Bohea	0 9	0 7	0 7 10

"The quantity sold at Deyra amounted to 308 chests, containing 3,588 lbs. 8 oz., of which 290 chests were bought by Europeans, and 18 only by natives None but black tea (Souchong and Pouchong) was offered, and realized very high prices, viz :—

	High.	*Low.*	*Aver.*
Souchong	5 4 0	2 4 0	2 8 11
Pouchong	2 12 0	1 5 0	1 10 2

"Nearly all the second class or cheap teas were purchased by natives, showing that all that is wanted, are sufficiently low prices to create a great demand. Those that now rule are still too high for natives, and must continue to be called 'fancy' ones, so that the speculation must pay handsomely.

"We look forward with much curiosity to the result of the coming sale at Hoosheearpoor, where the Kangra teas will be disposed of in the course of another month or so."

Teas from Java.

A great variety of teas were shown from the Dutch possessions in Java, which appear to be of good quality; but as I was unable to obtain any information respecting them, it may suffice to say, that the culture and manufacture seem to succeed there as well as in the Himalayas. It would be interesting to compare in all points the results arrived at in these several localities.

Coffee.

Tobacco culture.

Arabian coffee was first cultivated by the Dutch, and some of their plants first sent by the French to the West Indies. There it is now so extensively and successfully cultivated that Jamaica coffee bears the highest price in the English market. So that one has a difficulty in thinking of where it is indigenous, as it is a much more important article of agriculture in the West Indies, Java, and Ceylon, than in

its native countries. Though some parts of India are well adapted to the culture, it is not yet so extensively cultivated as might have been expected from the vicinity of its Arabian sites to the Malabar Coast. Here, however, some excellent coffee is grown, as well as in the hilly regions of Mysore and on the slopes of the Neilgherries, and some of these are of such good quality and so carefully prepared as to bring the same price as Mocha coffee. Some very good specimens of coffee have also been produced in the interior of India, as in the district of Chota Nagpore, where the culture might apparently be greatly extended, and be of great benefit for consumption in the interior of the country.

Tobacco.

Tobacco culture.

The interchange of useful plants has, in the several instances we have referred to, produced remarkable effects in the economy of nations. This is the case also with the tobacco, which, a native of America, is now cultivated in most parts of the world, and is being constantly introduced into new situations. The culture, though long known to the Arabs, has been taken up by the French colonists of Algeria, and 725,418 kilogrammes are reported to have been produced in the year 1855. The culture of tobacco has been introduced into the villages of almost every part of India, but chiefly for the consumption of the cultivators, though they do not understand or pay attention to the proper mode of curing tobacco as practised in America; so it is usually dry and readily falls to powder. It is therefore not well suited for export. This is not, however, the case with the Arracan and Sandoway tobacco, which has long been famous in the East. The last named place was formerly the site of one of the Portuguese settlements. This tobacco has of late years been exported in considerable quantities to Europe, while the cultivation has also been extending on the opposite coast of the Bay of Bengal, in the islets of the Godavery. There is no doubt that tobacco might become an esteemed article of export to Europe from thence as well as from other parts of India, if care was taken as much with the *curing* as with the growing of the leaf.

In Algeria.

In India.

Bengal rum and Indian opium do not require to be noticed, though both were exhibited, though there is a prospect of some of the latter being sent for sale to Europe.

Spices.

Spices from different localities.

The spices, which formerly brought such enormous prices, are now so much diffused that their culture does not probably afford more profit than other cultures. But their circle

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seems still to extend. Thus cloves and vanilla were exhibited from Mauritius, and round cardamoms from Java, from whence also there were specimens of cassia lignea as well as of the true cinnamon. Fine specimens of nutmegs and of mace were sent from Penang and Singapore, as well as from Travancore and Tinnevelly, in the peninsula of Madras. Cloves are produced in the same localities as well as in Cochin; cinnamon has long been introduced into the south of India as well as along the Malabar Coast; and cassia is a produce of these localities as well as of Travancore and Cochin. Cassia buds, similar to those imported from China, though produced by a different species of Cinnamomum, are also produced in Travancore, Cochin, and near Tellicherry. Along that coast the small cardamoms, and pepper, and ginger, and capsicum, are all ordinary articles of culture and of export, and it may thus vie even with the Spice Islands in the variety, and also in the quality of some of its aromatic products.

Preservation of Meat and Vegetables.

In connexion with articles of diet, it is not out of place to refer to the admirable methods which have of late years been adopted for preserving food of all kinds, in addition to the old ones of salt, saltpetre, and great cold: grains and hay being preserved by careful methods of drying. But before mentioning these, we may briefly notice that M. Martin, and after him, others have successfully practised the separation and preservation of the gluten of wheat, which is always lost in the ordinary preparation of fecula or starch, and which is known to be more abundant in the *hard* than in the *soft* wheats. It is now sold as *gluten granulé*, and is especially useful for making various substitutes for Italian vermicelli and macaroni, affording at the same time great facilities for changing the diet of patients in diseases where fecula is objectionable, on account of its being apt to become saccharine, and subsequently acid, in passing through the system.

Separation of gluten from fecula.

Preservation of meats.

The preservation of meat and vegetables by enclosing them in a vacuum in tin cases, is well known and extensively practised. Other methods of preservation are also now practised, as with sulphuric acid gas; covering them with gelatine; and lastly with glycerine, which is now so abundant a product in Mr. Wilson's improved methods of candle-making. Meat biscuits were a great feature of the Exhibition of 1851, so also preserved milk; of this still better specimens were exhibited at Paris: while the masses of vegetables preserved according to the methods of M. Masson are still more valuable contributions, as they enable the superfluities of the

country to be transported to the distant and crowded localities of towns, where a deficiency is at all times experienced, and also to be consumed in regions and at seasons where they could not otherwise be obtained.

Vegetable Products chiefly used in Manufactures.

Gums, Gum-Resins, and Resins.

Gums, Gum-resins, and Resin are to be found in large quantities and in great variety in most parts of the world, chiefly, however, in warm countries. But the pine tribe yield resins in the coldest climates, and what is called cherry-tree gum is produced in temperate climates by many of the stone-fruited tribe of rosaceous plants. The term Gum is so inaccurately applied in ordinary and commercial language, as to include also many of the resins, but these are at once distinguished by being soluble in spirit and insoluble in water. True gums, on the contrary, being readily dissolved in water, form mucilages, and are sufficiently digestible to be used as occasional articles of food. For instance, the gum-collectors near the west coast of Africa are said to live for weeks chiefly on the gum which they are employed in collecting. Africa is, indeed, the great source of the fine gums, which in commerce are usually called Gum Senegal and Gum Arabic. India also yields considerable quantities of an inferior kind, as does Australia; all which are the produce of different species of Acacia. The purer kinds are much employed in medicine for their mucilaginous properties.

Difference between gums and resins.

Gum from Africa, India and Australia.

A very great variety of gums are produced by other trees, but as many of these resemble cherry-tree gum rather than gum arabic, they are not so well suited for the purposes of the calico printer, for stiffening calico and other fabrics, or for giving a lustre to others. As it is an object of considerable importance to get gums for such purposes as cheap as possible, it seems a very desirable subject of inquiry for chemists, to ascertain the varieties in composition of the more abundant kinds, and to devise methods by which they might be made useful for the manufacturer.

Improvement of ordinary gums.

Resins so valued for making varnishes are greatly in demand, and new kinds, if of good quality, are eagerly sought after. A very interesting collection of those known in commerce was exhibited by Mr. Wallis. Among these, mastic, a produce of the Mediterranean region, is one of the most valued, but has become dear from its great consumption. It is not improbable that a good substitute might be obtained for it either from Arabia or Persia. Copal, a produce both of the west and and east coast of Africa, is remarkable for its purity, abun-

Resins.

Mastic.

Copal from Africa.

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dance, and the great size of the pieces, but the tree producing it seems to be unknown. But what is obtained from the east coast finds its way to Arabia, and is from thence, like some other African products, sent to Bombay; whence it is exported, and thus comes to be called East Indian copal. With this is sometimes confounded the light and also greenish coloured resin of *Vateria indica*, which, in its liquid state, is known on the Malabar Coast by the name of the *Piney varnish*. The purer specimens of this resin seem well suited for the uses of the varnish maker. A great variety of resins, produced by different trees, are spoken of under the name of Dammer, which in the Malayan Archipelago seems to be a name applied to resins in general, sometimes even to the resin of the Cowrie or Kaudi pine, and which is commonly known as *Cowrie gum;* it is produced by *Dammara australis*. The name is very frequently applied to the resin of *Shorea robusta*, which is an extremely useful and very abundant resin in the East, though perhaps not well adapted for making varnishes. But a very clear and pellucid, pure-looking resin was sent to the Exhibition, under the name of Dammar, both from Borneo and from Assam. It is more than probable that this is the produce of a species of *Dipterocarpus:* a genus belonging to the same natural family as the above Shorea and the Camphor tree of Sumatra, and which abounds in useful products, as, for instance, in abundance of the oleo-resin called *Wood Oil, or Gurjun,* which is much used in the East as a natural varnish for wood, and for paying ships. It is a compound of two very useful ingredients, that is, an oleo-resin-like copaiba, yielding a volatile oil which dissolves resin and caoutchouc. Gutta percha was sent from Singapore, and in connexion with it, it is interesting to state that it has been announced by Dr. Cleghorn that the tree yielding this substance has also been found in the forests of Mysore. Kutteemundoo, the inspissated milky juice of an Euphorbia, and having some resemblance to gutta-percha, is well worthy the attention of chemists, as is that of Calatropis and of other milky juiced plants.

Piney varnish and resin.

Dammers of the East.

Wood oil.

Gutta percha in India.

Ceylon gums and resins.

Besides the Indian collection of gums and resins, which was extensive, good collections were also shown from Ceylon and from Guiana. But many require careful examination and analysis before we can be aware of the uses to which each is applicable.

Vegetable Oils and Fats.

Oils and fats required in large quantities.

The extraordinary extension which has taken place in the commerce of vegetable oils and fats, would seem hardly to require any further development. But, notwithstanding the

enormous quantities of palm oil imported from the west coast of Africa, and of cocoa-nut oil from India and Ceylon, manufacturers here require every variety of vegetable oil and fat, and in any quantity in which they can be imported. Several of the Colonial collections exhibited specimens of new or little known oils, though that of India was, no doubt, the most extensive. Among them were some which are new to Europe, and which will require investigation; but others, which are comparatively little known, are probably the most important for early introduction. In the first place, among the solid oils or vegetable fats and butters as they are called, we have the vegetable butter of Canara, as it is sometimes called. It is of solid consistence, and admirably adapted for candle-making; it is produced all along the forests of the Malabar Coast, and is therefore easily accessible to commerce. It is obtained from the fruit of an excellent timber tree (*Vateria indica*), already mentioned as yielding the Piney varnish, and therefore affording facilities for the collection of two useful materials at the same time.

Great variety in colonies.

Vegetable butter of Canara.

Another fatty substance, which I have the authority of Mr. G. Wilson for stating would be extremely valuable for candle-making, is the Bassia butter, which is yielded by two species of Bassia, the *B. longifolia* and the *B. latifolia* of botanists,—trees yielding excellent timber, their flowers saccharine matter, which is fermented into spirit. This forms one of the most common araks or spirits in use by the natives of almost every part of India. The Illipie is common in the Madras Presidency, and the Muohwa in the Bengal Presidency, extending also all across Central India, even to the western coast. The butter is obtained from the kernels of the fruits of both species, and is much used by the natives of the country; but it might become an article of export, while they could easily employ some of the cheaper and abundant vegetable oils of annual plants, of which the cultivation can be readily extended. The *Illipie* was mentioned as *Bassia butyracea* in the Bourbon collection, but this species is a native of the Almora hills.

Bassia fat.

Some of these, under the name of mustard and of rape oil, as also their seeds, which are different species of sinapis, are already exported, as are also sesamum, or til seed, and the black or *Kalee* til. So castor oil seeds and those known as lamp oil seeds (species of Jatropha), safflower, sunflower, and similar plants, are abundant sources of oil; so also are ground nuts and poppy seed. But the great variety can only be known by examining full catalogues of such oil-yielding plants. The readiness with which the exports of some may be increased is evidenced in a remarkable manner with linseed. Of this 10 bushels were first exported in the year 1832, but which

Oil seeds.

in the year 1850–51 had increased to,—from Calcutta; 765,496 maunds, each of 82 lbs.; 801 cwt. from Madras, and 50,112 cwt. from Bombay.

Greatly increased exports from India.

The latest accounts mention the export of linseed from Calcutta alone to have increased from 12,13,775 maunds in the previous, to 17,15,176 maunds during the last year, and mustard seed from 3,58,234 in the former to 13,92,110 maunds in the latter.

As the foregoing increase of the export of linseed from India did take place during the long peace, it is evident that it can be produced, and yield a profit to all concerned, even at ordinary prices: and this notwithstanding the great distances which the linseed has to traverse, both of land and of ocean, before it can reach English ports. In the year 1854, as a necessary result of the declaration of war with Russia, considerable increase took place in the prices of the chief exports from that country. Large quantities of linseed were ordered from India, but losses were in some cases sustained in consequence of the variations in price, as, for instance, from 54*s.* in January to 70*s.* in March, and 56*s.* 6*d.* at the end of August, though the price rose again later in the year. These depended on the uncertainties prevailing respecting the blockade of the Russian ports. In 1853–54 upwards of a million of quarters of linseed were imported, but it was calculated that in 1854–55 the imports would not amount to above 700,000 quarters, of which India was expected to furnish a good proportion. But at the end of 1855 we find the brokers reporting that "the range of prices and source of supply are altogether different from former years; and the latter consequence of the war is a subject for great congratulation, and more than reconciles us to the loss of Russian produce, inasmuch as it so materially benefits our East Indian possessions. Already do we receive as much from there alone as the total import of some years since; and should we have a protracted war, the larger cultivation and the increasing facilities of transport in India will render us wholly independent of Russia." Owing to this source of supply, the total importation was only less by 100,000 quarters than in 1854, and 300,000 quarters under that of 1853. With this it may be observed that new sources of supply will be added to those which have been yearly increasing their cultivation, for both Sindh and the Punjab have taken up the cultivation of linseed, and will probably be able to produce flax.

Tanning Substances.

Astringents, useful in medicine and essential in the art of tanning, are very abundant in warm countries, and might be imported in any quantities, if the freight did not throw impediments in what are usually bulky articles; for they are commonly the bark or wood of trees, where the astringent principle is mixed with much other vegetable matter. But as this principle can in some cases be usefully separated by the action of water, so gambir, the produce of a tree on the Malayan peninsula, has been largely imported a :a tanning substance, as is also catechu, often called terra japonica, the extract of another tree (the acacia catechu), though obtained also from other sources. Kino is an astringent exudation, which hardens into a brilliant gum-like substance, which is much esteemed for tanning, but from the small supply is usually too dear; but the tree (Pterocarpus marsupium) yielding the best kind of Kino, has been found on the eastern coast of the Bay of Bengal and in some of the forests of Central India, though at one time thought to be confined to the Malabar Coast. The Butea kino is also a useful tanning substance, though found to be difficult of management; it has been proposed to make extracts of several other astringent woods and barks which are favourably situated, as, for instance, of the mangrove. Other substances, as galls, are sufficiently compact to bear the expense of distant transport, and we obtain them both from Smyrna and from India, though each the produce of near Moosul. The tamarisk gall, produced abundantly in the north-west of India, might form an export from Sindh in much larger quantities than it now does. Some of the plants of the New World are being cultivated in India as the Libidebi or Cæsalpinia coriaria, which yields an excellent material for tanning.

Astringent extracts suited for export.

Oak galls.

Tamarisk galls.

The leather tanned in India under European superintendence is of excellent quality, as by the Messrs. Teil, in Calcutta, and by the Government establishment in Mysore, from both of which localities excellent specimens of leather were sent to the Paris Exhibition. The materials used in India are chiefly barks of species of Acacia, and also of some Cassias, and the fruit known by the name of Myrobalans, which is useful also as a dye.

Dyes.

The rich and harmonious colouring of the varied manufactures of India, has always attracted much attention to the natural colours and dyes of the country in which these

Indian dyes.

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pleasing results are produced. There is no doubt that the country, as well as many others which are less known and still less explored, abounds in an endless variety of materials which may be turned to the purposes of the dyer; some of these are well known in Europe, others comparatively or entirely unknown. Specimens of many of all kinds were sent to the Exhibition from India, and many of them accompanied by their mordaunts, as well as with specimens of cloth dyed of the several colours. These will all afford useful subjects for future investigation. It may be thought that many new dyes are not required, as so many shades may be produced with the old ones. But I am informed by a very intelligent dyer, that he finds every dye possesses some useful and peculiar property which makes it more useful than any other for some particular purpose. Some of these will become more valuable from the methods which are becoming adopted of separating the dyeing principle from the rest of the vegetable matter, as is done, for instance, with the indigo and annotto among vegetables, and with the lac among animal products. This has also been effected with the dye

Dye of Butea flowers.

of the flowers of *Butea frondosa*, which form so rich an ornament of the jungles of all parts of India, but of which the bulk renders them unsuitable for transport to distances. One of the colours most admired by some artists at the late Exhibition was a kind of lemon yellow, as seen in some silk scarves from the Punjab. It is more than probable that this colour

Datisca cannabina

is produced by the roots and stems of a plant called *ihl-beer*, which is there much esteemed for dyeing silks of a yellow colour, and which I believe to be those of *Datisca cannabina*, a plant found as well in Europe as in the Himalayas. Dr. Stenhouse having analysed the Punjab specimens, found that they yielded *datiscine*, which had already been discovered in the European plant. Some of the Indian lichens tested by the same chemist did not give any favourable results, though some very promising ones had been obtained from another set of Indian lichens by Mr. Piddington.

Green indigo.

A very interesting new dye was the so-called *green indigo*, of which a specimen was at my request exhibited by Dr. Falconer. It is further interesting, as one kind of this dye is employed by the Chinese, another by the Burmese, and this third kind was obtained from the valley of Assam. All are the produce of species of acanthaceous plants, and will no doubt attract the attention of both chemists and dyers.

Improved Lac dye.

A very important result has been attained by Mr. Henley, as he exhibited specimens of cloth dyed scarlet both with the best cochineal and with lac dye prepared by a new pro-

cess of his own. The result is not only that the colour is as brilliant as that produced by the cochineal, but Mr. Henley states, that his lac dye can be afforded to be sold for one fourth of the price of the cochineal.

Cotton and Fibrous Substitutes for Hemp and Flax.

Cotton is a product of such vast importance to the manufacturing prosperity, not only of this but of other countries, that any fresh sources of supply cannot fail to be of interest both to the merchant and to the politician. Several such have of late years been announced, but their progress has not been sufficiently great to attract any subsequent public attention. The imports, however, continue to increase, having been upwards of two millions of bales in the past year, including an increase of near 90,000 bales of cotton from India. This latter import depends not only upon the price being high in Europe, but also upon the demand in China.

Cotton from Australia.

Some very good specimens of cotton were shown in Australia, and if labour were cheaper, there seems no doubt but that much excellent cotton might be produced in situations where there was sufficient moisture of soil or of climate. A curious result of this growth of good cotton of the American species was seen in a piece of muslin, which had been woven by Dacca weavers with fine thread spun in Manchester. It was shown in the Australian department, because the cotton had been grown there, though for the same reason Manchester goods might have been exhibited in the American quarter.

Cotton from Algeria.

Considerable attempts have for several years been made to grow the American cotton-plant in Algeria, and if we were to judge from the number of cultivators and from the value of prizes which have been at different times awarded, we should conclude that the success must have been considerable. So also, if we look at some of the entire plants exhibited in the dry state, we find them well branched, and bearing numerous bolls of a good size, and well filled with good cotton, proving that the locality where these were grown must be favourable to the production of good cotton. If we look also to the success in Egypt, there would appear to be nothing in the climate which is unsuitable. But then it must not be forgotten, that it is only in consequence of the facility of irrigation by the overflowing of the Nile, that the culture succeeds there; and therefore, if there are facilities in this respect in Algeria, it may equally well succeed. Otherwise I should think that the dryness of the climate

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would in many parts prevent a full crop being obtained. I was unable to ascertain the quantity of cotton obtained per acre, and the expenses of culture, as well as the profits of this, in comparison with other cultures.

Culture of cotton in India.

It is generally well known that various attempts have been made in the last fifty years to grow American cotton in India, and notwithstanding the favourable reports and fine specimens, the culture has taken root but in few places. This, not because there is not enough of heat or of moisture for the growth of the plant, or of fair weather for the ripening of the cotton; but from the want of a due proportion in which these are supplied to the growing plant at the times when they are required. This I have shown in a special work on the subject,* and therefore need not refer more particularly to the subject.

In Dharwar.

In that work it is stated that nowhere were the prospects so favourable as in the district of Dharwar, apparently from its having the benefit of the two monsoons. These prospects are in the course of being fully realized. For the cotton grown by the natives themselves from acclimated American seed, and bought by the Indian Government at a price above that of the native cotton, and sent to the English market, has been always sold in Manchester at a profit. The culture, which is now entirely in the hands of the natives, has steadily increased, as it has been reported that in the season 1854–5 there were under cultivation in the Dharwar district 63,298 against 41,403 acres in the preceding year. Mr. Frost, the engineer for making cotton-cleaning machines, reported that year that "in the course of time, it (that is, the American cotton) will be cultivated in every field in which it will grow, and the native cotton will have to make room for it." The number of saw gins of different sizes, which were made in the Government factory, and sold at cost price to the natives, for cleaning the American cotton, were stated by Mr. Frost to be upwards of 300. The price of this Dharwar-grown American cotton in the Bombay market was 120 rupees per candy of 784 lbs., when the native cotton was quoted at about 90 and 100.

Cotton in other districts.

In the neighbouring district of Belgaum 1,911 acres were in cultivation, and in Ahmedabad 254 acres. But in the Candeish district, where there were 1,696 beegas in 1853–54, there were in the following year only 16 beegas. At the Exhibition of 1851 a great variety of specimens of cotton were displayed in the Indian department, but it was not thought necessary, especially from the want of space, to do

* Culture and Commerce of Cotton in India, by J. F. Royle, M.D., F.R.S., 1851.

more than show the kinds which are common in commerce, as the above Dharwar, the Broach, the Tinnevelly, &c. In connexion with the Broach cotton, we may refer to the establishment in that district by Mr. Landon of cotton-spinning machinery, from which the first samples of yarn sent into the Bombay market sold at prices somewhat above the same numbered yarns from England. A spinning factory has long been established in the vicinity of Calcutta.

Cotton spinning machinery established in Broach.

The Russian war has enhanced the price not only of linseed but necessarily also of flax and of hemp. Though this had the effect of greatly increasing the imports of Indian linseed, and probably also of its cultivation in India, it did not have the same effect in Ireland, as the flax crop there of 1855 was by 35 per cent. less than that of the preceding year, owing partly to want of adequate remuneration in the previous year, and partly also to cereals, more particularly wheat, paying better during war. It has been expected, and not unreasonably, that where much linseed is grown, there flax might readily be produced. This, however, is not so easy, unless the climate is favourable; as it is quite possible to have one which is suitable to the ripening of the fruit and seed of a plant, and not be so much so for the production of long fibre. Such, indeed, is the case with many parts of India. But I have do doubt that ordinary flax, such, indeed, as is most wanted for some of our manufactures, may yet be produced in India, and sent profitably to the English market. This is already the case with other and cheaper fibres, of which we may observe that large quantities were imported in gradually increasing quantities even before the war.

Flax.

Quantities of Hemp imported into the United Kingdom.

	1831.	1851.
From Russia - - - - - -	506,803	672,342
„ British territories in East Indies -	9,472	590,923

Of this return we may observe that, though under the head of hemp from Russia, it is certain that only the true hemp is included, but under that from "British territories in the East" it is probable that no true hemp is included, though the plant is grown in the country for its intoxicating secretions, but produces strong fibre in the Himalayas. But as the fibres which are imported are all such as sell at lower prices than hemp, it shows how well the country, though distant, is able to carry on the trying competition. These are facts of great importance; for India possesses fibres of every quality and strength, as I have endeavoured to show in a

Hemp and other fibres from India.

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work dedicated to the subject.* The exports of fibres have considerably increased from India during the last year. The true hemp, moreover, as mentioned above, is produced of great strength in the Himalayas; and it is interestiug to state, that 32 bales having been sent as a sample for trial to this country, have just reached the India House.

Other fibres.

The white fibres, such as Manilla hemp, plantain, agave or aloe, sanseviera, &c., may be applied to various purposes, some of them for textile, and others for ordinary cordage, all of them taking and retaining colour when dyed. Indeed, we see the Manilla hemp and aloe fibre, as it is called, applied to a variety of purposes in France, as for making fine cordage, mats, bonnets, and lately even introduced into ribbons. So some of these separated by the Italians, have been called *Soie nouvelle* and *Soie perellene*, and applied to a variety of purposes.

China-grass in India.

The fibres of the Indian plants *ambaree* and *sunn*, when of the best quality, are well calculated to supply the place of hemp, while the Rhea fibre, which is probably the same as "China-grass," requires only some machinery to be applied to its preparation to undersell Russian hemp, as it excels it in strength. The cultivation of the China-grass in France, to which attention has for some time been called by M. De Caisne, cannot fail to enhance the value of the foreign article, by having its properties both well ascertained and made more generally known. The existence of these various fibres would have been much more valued, if it had not been for the continued imports *viâ* Memel of Russian hemp into this country.

Introduced into France.

Fibres well fitted for cordage.

The excellence of some of these fibres for cordage has been admirably shown in the specimens of rope sent from Calcutta by Messrs. Harton, as well as in the ropes made of Rheea fibre in this country. The great attention which has been paid to the subject of fibres of late years was conspicuously shown in the collections displayed from the British dependencies, as from India, Guiana, Jamaica, &c., and also in the collection from Algeria.

Collections of fibres from colonies.

Fibres for paper-making.

The fitness of many of these fibres for conversion into paper was also shown in various specimens of paper made of plantain and of aloe fibre, of that of the Screw pine, of the sunn of India, also from Daphne cunnabina, bamboo, &c., and even from the fibres of the jute, by Mr. Hollingsworth, in the form of silver, writing, and cartridge paper; though it has been said that this fibre cannot be bleached.

* The Fibrous Plants of India fitted for Cordage, Clothing, and Paper, 1855.

Woods.

Excellent collection of woods from colonies.

The collections of woods from several of the colonies were among the conspicuous objects of the Exhibition, as will no doubt be described; for the rich furniture woods of Australia, the hard woods of Guiana, the variety from Jamaica, the deals from Canada and Norway, all attracted universal attention, as well as what has been supposed to be one of the kinds of cedar of Scripture, the "citrus" of the ancients, produced by the Thuya d'Algerie, *Thuya articulata*, now *Callitris quadrivalvis*, which abounds in Algeria as well as in other parts of the north of Africa.

Teak forests.

The collection of woods from different parts of India at the Exhibition of 1851 was extremely large, amounting to nearly 1,000 different species. From the known want of space, it was not possible to exhibit more than a few of these woods. Few are known to commerce; but *Poon* (Callophylli species) spars are exported from the Malabar Coast for the use of the British Navy, and the Teak sometimes both from the west coast of India and from that of the Bay of Bengal. The forests of Canara and Malabar having for many years been left to the care of the natives, were fast dwindling away: but the judicious measures adopted by Dr. Gibson, have in a few years been productive of beneficial effects. Similar care has been devoted to the forests which are within the precincts of the Madras Presidency. The teak forests of Pegu will require constant attention, or they will also be destroyed from the reckless proceedings of woodcutters thinking only of present gain.

Other timber trees.

In the interior of India, the *Sal* (Shorea robusta) and the *Sissoo* (Dalbergia sissoo) are the most valued timber trees, while the Toon (Cedrela toona) is much used as a furniture wood, as are ebony and blackwood (Dalbergia latifolia) in Madras and Bombay. It is more than probable that continued attention will be required to extend and preserve the natural forests.

Deodar plank.

A fine plank of Deodar, four feet in diameter, was exhibited from the Himalayas. It is an interesting fact that some of the bales of shawls were packed in thin planks of Deodar wood, and some of the boxes containing goods from the Punjab were also made of Deodar wood. These, in addition to the preference in which it is held for boat-building on the Sutlej, show how much it is appreciated in the vicinity of the mountains where it grows, and how valuable is the introduction of the tree into this country of which thousands of the seeds have annually been distributed by the Court of Directors of the East India Company.

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In connexion with woods, it is interesting to refer to the various modes of preserving timber, as this saves the best; and makes the inferior timbers useful for various purposes to which they could not otherwise be applied. The *bois-marbre* was also an interesting object of attention, as one in which the different kinds of woods are imitated by uniting the sawdust of the different woods with some agglutinating material.

Products of the Animal Kingdom.

The animal, like the vegetable kingdom, affords in all its departments numerous products useful to man in all parts of the world. The utility of some for food, and of others for carrying or for dragging loads, is too well known to require further notice, than that in proportion to their utility is the importance of the various measures for improving the breed of animals and for introducing them into new situations where they can find a congenial climate and suitable food. But as we have only to notice a few points of this extensive and important subject, we may, as in the case of vegetable products, notice them under the head of proximate principles.

Isinglass, Shark Fins, Birds' Nests.

These apparently incongruous substances may be treated of together, for they are valued in consequence of all abounding in the substance called gelatine, distinguished by being soluble in boiling water, and forming a tremulous or solid jelly when cold. The great source of the purest isinglass is well known to be the swimming bladders of sturgeons (Genus Acipenser) which inhabit the rivers falling into the Black and Caspian seas. The Paris Exhibition contained some very interesting specimens of a result of the Exhibition of 1851, that is, some fine specimens of isinglass obtained from the sturgeons which abound in the rivers and lakes of North America. Professor Owen having called the attention of the Commissioner from Canada in 1851 to the existence of this fish in the above localities, and to the value of their swimming bladders, the Paris Exhibition displayed, as a result of this observation, numerous specimens of isinglass, now becoming an article of export from Canada.

Isinglass from Canada.

Isinglass from India.

The numerous coasts of the Indian seas have long been swept for the same substance, though produced by a different fish (a Polynemus), indeed, by several other fishes, though it does not appear in Indian price currents under the name of isinglass, but under that of fish-maws. Of these, large quantities are constantly taken to China, where it receives the

expressive name of *fish-sago*, and the great love of the people for all kinds of gelatinous dishes, makes these in constant demand, as well as sharks' fins and the edible birds' nests.

Sharks are therefore constantly caught all along the coasts of the Indian seas, and are now still more valuable to the fisherman, as a considerable demand has arisen for all kinds of fish oil. This, though it has been long known on the Malabar Coast, has only lately become a regular article of export from India to England. The shark yields one of the kinds of fish oil exported from India.

Shark fins.

So the esculent nests of the salengana or swallow of these eastern seas are valued on account of their gelatinous properties, and are prized in proportion to their purity, together with sea-slugs and agur-agur, a species of sea-weed.

Silk and Wild Silks of India.

Of the various raw products, none were displayed in such variety, or which made so brilliant an appearance as silk. For here we had the chief districts of France vying with those of Italy, while Greece and Spain, India and China, all sent contributions characteristic of their respective cultures. But according to various Continental manufacturers whom I saw, it seems hardly possible to produce as much silk as is required for the increasing demands of trade. Among these, I was surprised to find that the silks of India were comparatively so little known even to many manufacturers, who said they had never seen such silk from India as was exhibited by Messrs. Watson and by Messrs. Lyall. These were probably not superior to what is usually imported into this country, but here I am told the regularity of demand and the prices can be more relied upon by importers, and therefore the best silk is sent to the English market.

Wild silks of India.

I was still more surprised at the numerous inquiries made respecting the wild silks of India. These were very well represented in a case of the insects with their cocoons, prepared by Dr. Huffnagle, of Calcutta; while numerous specimens of the several manufactured silks were sent from Bengal and Assam. Before proceeding, it is necessary to notice the various kinds, though it is difficult to do so with great accuracy, from the different names given to the same insects in different districts. But, from the specimens of silkworms exhibited, and which were examined by Dr. Milne Edwards, the following species may be made out, though some others are mentioned in Indian journals:—

1. *Saturnia atlas* is said in some works to yield the *tusser* or wild silk of China; one kind, however, of this is known to be yielded by the true *Phalæna Cynthia*.

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2. *Saturnia Mylitta*, sometimes called *S. Paphia*, and also *Phalæna Paphia;* yields the *tusseh* or *tussur* silk of India, and is known by different names, but feeds generally upon the leaves of *Terminalia Catappa*, *Pentaptera glabra*, and *Zizyphus Jujuba.*

3. *Saturnia assamensis*, sometimes called *Bombyx Saturnia*, is the *Moonga* of Assam, and may, perhaps, include the variety called Mazankoore; it feeds as above; the latter variety on the leaves of species of Tetranthera and of other Laurineæ.

4. *Saturnia Arrundi*, usually called *Phalæna*, and also *Bombyx Cynthia;* it is the Eri of Assam, and feeds upon the leaves of Ricinus communis.

5. *Bombyx Mori*, or common silkworm moth, which feeds upon mulberry leaves, is the Pat of Bengal.

The Eri of Assam introduced into Europe.

Some of these species have been inquired after, not only for the silk which they produce, but also for introduction into Europe, especially France; as, for instance, the Chinese silkworm, which lives upon the leaves of a species of oak, and also the Eri of Assam, which feeds upon the leaves of the *Ricinus* or castor-oil plant. Success has been obtained with the latter through the aid of Mr. Piddington, curator of the museum at Calcutta, and of his Excellency Sir W. Reid, governor of Malta. He however, reports (7th July 1855) its complete failure in Malta during last summer, though its numbers increased so rapidly in the year 1854, that no doubt was entertained of the success of acclimating this silkworm in the south of Europe. Sir William further says, "In Italy they promised to thrive, and succeeded the first year; but I understand that this year they have failed also in Italy.* I have not recently heard whether others sent to Algeria are or are not prospering." M. Hardy, writing in September 1854, seemed to think, from the results which he had obtained, that he was almost certain of success in naturalizing this kind in Algeria. It must, however, be observed that the climate of Assam, where this Eri silkworm flourishes, is a warm and a moist climate, exuberant with tropic-like vegetation, while the countries into which it had been introduced, though warm, are rather remarkable for dryness of climate. In addition to sending the *Bombyx Cynthia* to the above countries, Sir W. Reid successfully sent it from Malta to the West Indies. About thirty fresh cocoons were placed in birdcages. On the voyage the chrysalides became moths; these laid their eggs, and these eggs began to hatch on their arrival at the island of Grenada. Mr. Wells, writing from thence in November 1855, says they† "perfectly succeeded, as far as relates to

Introduced into West Indies.

* Messrs. Bellini, of Rivoli, did not find the results repaid them for the trouble.

† Journal of Society of Arts, 1855.

their being adapted to this climate, and to their propagating rapidly, and perfecting their cocoons. This is abundantly proved from the fact that this day (being twelve months from their introduction) I have the eighth generation of worms now hatching, having had seven crops of cocoons within the year." But there we have a suitable climate and congenial vegetation, and if labour is abundant, the Eri may perhaps answer as well as in its native sites.

Produce of the wild silkworms.

The silks produced by these silkworms are, however, worthy of the attention of manufacturers. The tusser is the most abundant product, inasmuch as it is found in many of the forests all along the foot of the Himalayas, as well as in Central India. It is everywhere used as clothing by the natives of the country, and even by Europeans; while considerable quantities of the woven tusser is now imported into this country, though apparently but little known on the Continent. But one French manufacturer had commenced making some plush-like material, of different colours, of the *tusser*, as he said, imported from China. The Indian tusser is at least equally well adapted for the purpose, and both the Eri and the Moonga silk seem worthy the attention of manufacturers for various purposes, from their strength, durability, and cheapness.

Mulberry silkworms.

The display of the silk of the mulberry silkworm was, as I have said, both varied and splendid. Greece, the country into which it was first introduced, from Asia, exhibited the success with which silk is still cultivated there. The silks of Piedmont, both raw and organzine, were very fine, and the exhibitors numerous. But the southern provinces of France proved, from their specimens, that they are as favourable as any for the culture of the silkworm. The exhibitors were very numerous, and the art of silk-throwing shown to be carried to a high state of perfection, while others displayed the care with which the habits of the animal are studied. The silk of M. Broski was as beautiful as exhibited in 1851, but it does not appear to have yet become abundant.

Experiments in silk culture in Bengal.

The culture of the mulberry silkworm (*Bombyx mori*) was early introduced into India from China, where it flourishes chiefly about Nankin, or in 32° of north latitude; but in India none of the older silk filatures extend to beyond 26° of north latitude. This can, I conceive, be ascribed only to the excessive heat and dryness of the north-western provinces of India, being unsuitable to the animal, besides producing a dryer and harder leaf than it likes for its food. The *country-wound* silk, that is, silk cultivated and reeled by the natives, was in so much disrepute about the middle of the last century, that several Europeans were sent out, when "it was deter-

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mined that the method of spinning and dressing the silk as practiced at Novi in Italy was to be adopted in all the plantations." From such beginnings has the silk trade of Bengal become established as one of the great staples of that country. In the year 1852–3, silk, to the value of 69,41,599 rupees was exported from Calcutta, together with 32,08,901 rupees' worth of piece goods. The raw silk sent by Messrs. Watson, as also by Messrs. Lyall, both from Bengal, were much admired by the Jury of the Silk Class, and medals awarded for both.

In Madras Presidency.

As early as the year 1791, experiments for the introduction and culture of what succeeded so well in Bengal, were made in the Presidency of Madras, and continued for several years, but without any permanent results; as in the year 1854 only 1,666 lbs. were exported. This is probably owing to the climate of the Madras Presidency being generally unsuitable to the culture.

In Mysore.

For, in the more elevated climate of Mysore, experiments have been continued to the present time, and some very good specimens of silk were sent to the Exhibition both of 1851 and of 1855: also to the Exhibition held last year at Madras; when it was stated as probable that the culture may be successfully carried on in the valleys of the Neilgherries. The silk produced in Mysore is required for the manufacture of the silk shawls of that province.

In Bombay Presidency.

In the same way experiments were made in the Bombay Presidency about the year 1775, repeated again in the Deccan in the year 1830, and persevered in for ten years under the superintendence of an Italian, M. Mutti, but without eventual success, as was always anticipated by Dr. Gibson, in consequence of the heat and dryness of the climate.

Experiments on silk culture in the Punjab.

Though these instances may appear to put limits to the extension of silk culture in India, and to a supply of raw material from that country; they only do so in the districts having the climate which has been indicated. In the valley along the foot of the Himalayas in North-western India there is a less arid soil, a more temperate climate, and species of mulberry appear indigenous and flourishing. This is still more the case in the lower hills which bound the Punjab, and in many parts of the Punjab itself. Here, indeed, a most successful experiment has been commenced, of which the results were shown in the Exhibition. These consisted of specimens of the silk of two seasons; that of the first year was pronounced by Messrs. Durant to be of a good quality, strong, and apparently obtained from healthy cocoons. The reeling, however, was considered very defective, and the silk had what is called a *crapey* appearance, and on this account was considered worth not more than 7*s.* or 8*s.* per lb. But M. Deverinne, well acquainted with the reeling of silk in

Bengal, having been sent up by the Indian Government, the reeling of the next season's silk was greatly improved. This was pronounced also by the Messrs. Durant to be a most creditable effort, and obviously the work of a person who understands the reeling of silk, and though with some defects, this silk was valued at 15*s.* per lb.

Though there is considerable demand in the Punjab for raw silk, which is at present imported from Bokhara, as well as from China and from Bengal, it is probable that in time, enough may be produced even for export; especially as there is a favourable climate in the same district where China tea is being successfully cultivated, with an abundant and unoccupied population.

Wool, Camel and Goats' Hair.

Principles for guidance in wool culture.

The collections of wools in various parts of the Exhibition were extensive, varied, and interesting, and will no doubt be fully dwelt upon by the Jurors within whose province wools are included. They might be considered either as the produce of different breeds of sheep or of different countries. In doing this, we should find that their qualities, as fitted for different purposes, depend upon the influence, not only of breed, but also of climate and of food. For, as I observed on a former occasion, "in considering the probability of the production of wool, we have to consider the best breeds of the animal suited to the climate in which they are to be placed, as well as the pastures upon which they are to be fed." Various causes, therefore, interfere much with the success of any experiments which may be made for the introduction of superior breeds of sheep into new localities, and for the improvement of their wool. This, it is obvious, must depend upon the food and climate being suitable to the breed of sheep which has been introduced into it. For, if the locality is deficient in these respects, the sheep can as little thrive as the wool improve; and for these reasons one breed of sheep, even though not the best, may yet be superior to another for introduction into particular localities.

Australian wool.

Thus, with regard to Australia, the sagacity of the late Captain Macarthur, as early as the year 1790, conceived that both the pastures and the climate were well suited for the breeding of sheep and for the production of wool. He began his experiments with some small Bengal sheep, which are perhaps the least fitted of any Indian sheep for the purpose. He obtained some Merinos from the Cape of Good Hope in the year 1794, and a fresh supply in the year 1805. The Bengal sheep were found to be very prolific, but the cross had the disadvantage of taking more after the hair-bearing

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sheep of Bengal than the wool bearers of Europe. Captain Macarthur determined upon keeping the Merino breed pure, and his sons sent some of the wool of these flocks to the Exhibition of 1851, where it was greatly admired, and a prize medal awarded. These sheep have been the source of most of the fine Australian wool, of which such large quantities are exported. For no other importations of the purer breeds of sheep are known to have taken place until about the year 1825. About this time the Australian Agricultural Company imported fine-woolled sheep from both France and Saxony. The results of crossing the improved Australian breeds with these sheep, are seen in much of the wool which is now imported into this country, and which is so highly esteemed in the London market.

The tract most favourable for sheep farms is said to extend from about lat. 23° on the east coast, to Port Lincoln in lat. 35°. All to the south-eastward of this line, about 250,000 square miles, maintains numerous flocks of sheep, yields suitable pasture, has a favourable climate, and with the neighbouring colony of Van Diemen's Land, yields most of the Australian wool which is imported into Europe, but chiefly Great Britain. Of this 163,192 bales were imported into the principal ports during the year 1855.

Wool from the Cape of Good Hope.]

Some early attempts were made to improve the breed of sheep at the Cape of Good Hope. We have seen, indeed, that some Merino sheep were early introduced from thence into Australia, but apparently without much effect. Similar experiments have, however, been resumed, and high prices are given in the colony for Merino rams. Great improvements have been made in the improvement of wool in that colony, and the exports have greatly increased, as

	1833.	1849.
From Cape Town -	73,324 lbs.	1,567,212 lbs.
„ Port Elizabeth	39,753 „	3,457,734 „
	113,077 „	5,024,946 „

The quantities imported into this country amounted in 1855 to 38,272 bales.

But one defect of South African wool grown in the interior is that it arrives in a dirty state, and not so clean as purchasers wish: but this is partly owing to the want of streams of water at convenient distances from the sheep runs. Hence the sheep farmer is often obliged to sheer his sheep when in a greasy and dirty state, and then cart his fleeces to a suitable spot for washing.

From the south we may proceed to the north of Africa, where we have in Algeria vast tracts of country, supporting, it is said, about 8,000,000 of sheep, and likely to yield not only large quantities, but also improved qualities of wool. Several colonists have commenced improving the breeds of indigenous sheep, some with rams obtained from Naz, in France, others with Merinos procured from Perpignan. Numerous specimens of the improved wool have been exposed, and some of the wool of the cross breeds sold for 280 francs the 100 kilogrammes, when the indigenous wool sold only for 140 francs. Though we can hardly expect fine American cotton and superior wools in the same district, there are probably many parts of Algeria where fine flocks of sheep may be maintained, and superior wool become an article of export. It is curious that Columella, who occupied a farm in the Pyrenees, mentions the improvement of sheep by the introduction of rams from Africa.

Wool from Algeria.

From the north of Africa we might pass to the parts of Asia in the same latitudes, which from the earliest periods have been pastured by innumerable flocks of sheep, and where the inhabitants were probably the first to clothe themselves in wool. But little of this is accessible to commerce, from being far in the interior, and from the want of navigable rivers. For where these exist, we find the wool of these inner tracts making its way to the coast, and being quoted as an article of commerce; as, for instance, the wool which is said to be Indian, because imported from India, and to the amount of 15,045 bales in the year 1855.

Wool from Asia.

This wool is chiefly produced in the countries which lie on either side of the Indus, as well as in Beloochistan and Affghanistan, whence some makes its way to Sonmeanee and Kurachee. Thence it is taken to Bombay, where it is joined by the wool from Cutch and from Marwar, with a little from the Deccan. The exports of wool from India first took place in the year 1834, when 69,944 lbs were exported, but since then in greatly increased quantities as above noted.

Wool from Affghanistan and Beloochistan, &c.

Lately specimens of the wools produced in the Punjab, and in the countries along the foot of the mountains, and in the Himalayas themselves, as well as sheep and goats' wool from the Tibetan-like country on their northern face, were sent to this country for their values to be ascertained.

Of these wools, the goats' hair or wool is unsuitable to the English market, from being so much mixed with long hairs as to be unfit for use in English machinery, until these hairs have been picked out. The price is also so high that loss would certainly be sustained unless sent in a clean state, when it might be sold for the shawl and similar manufactures.

Goats' hair or wool.

The black wool of the Punjab and of the Umballa district is little esteemed, and there is a prejudice against black wools; but that from Goojerat might be used for some purposes, from being a long combing wool.

Punjab and Himalayan wools.

The mixed wools, though called white, are not so in the specimens. These also are little esteemed.

The Himalayan wools from the district of Simla are well thought of, as being adapted for the English market, being valued at from 9*d.* to 13*d.* per lb.

The white wools from the Punjab are also considered to be well adapted for the English market, and the cleaner kinds, though few, are free from hairs, and valued at from 7*d.* to 11*d* per lb. These, like the Himalayan wools, would sell higher if sent in a clean state.

Wool of north-west India.

Wool is produced in considerable quantities along the north-west frontier of India, but it is used up by the inhabitants for making their blankets, cloaks, rugs, and carpets. Blankets, which sell for one rupee each at Saharunpore, have, I am told, been exported with profit even to Australia. Wool is also produced on the western side of India, as in Candeish and Guzerat, also in the Deccan, and proceeding southward, likewise on the table land of Mysore,

Wool culture in Bombay Presidency.

Experiments were for some years made in the Bombay Presidency for the improvement of the breed of sheep and of their wool. It was then ascertained that the Cape-bred merino sheep, were better adapted to the country than those imported from England. Though the experiments were persevered in for several years, no permanent effect seems to have been produced.

Wool culture in Mysore.

In Mysore similar experiments have long been carried on, and certainly with the result of producing some fine wool from crosses with merino sheep: but the progress has not been rapid, nor the culture extensive. Mr. Southey informs me that he lately sold some eight or ten bales of this Mysore wool, which brought 20*d.* per lb., also that a part of it very closely resembled some Saxon wool. Mr., now Sir W., Macarthur has informed me that he had for several years sent every year, six of his merino rams to India. The Jury at Madras state that Mr. Fitzgibbon, in charge of the sheep farm at Hargunhully in Mysore, had made great endeavours to improve the merino breed of sheep, and had sent an interesting set of specimens of excellent quality. But only 79,072 lbs. of wool were exported from the whole Madras Presidency during the year 1855.

Wool culture in Hymalayas.

The Himalayas are well suited to the production of such wool as is required by the English manufacturer, and the quality, already good, might probably be much improved, as

the climate is excellent, and the pasturage nutritious. Of these the natives take advantage, by driving their flocks to different elevations according to the season of the year. Some experiments were made for improving the breed, but unfortunately, I think, with merino sheep, which do not appear to me as well suited to a climate which is so rainy for three months of the year, as are some of the English breeds of sheep.

As a very valuable Report has been published by a Deputation from Bradford, for a copy of which I am indebted to Mr. Edward Waud, I beg to be allowed to quote a few passages from the Report:—

"After giving a mere passing glance at the English and Australian wools, which were well represented, the qualities of which are too well known here to require any comment, the Committee beg to call the attention of the trade to their observations upon Continental, and more particularly upon French wools, many of which well deserve the especial notice of the staplers and spinners of this district.

French wool. "They are not aware that any important quantity of French wools has ever come into this market, although many of their sorts possess qualities which peculiarly fit them for our manufactures. The duty on exportation of wools being only nominal, namely, one penny farthing per hundredweight, there is no impediment on the part of the French government to their being imported into England.

Austrian wool. "Of French wools there was, indeed, a great variety, many of them of beautifully fine and long fibre, suitable for combing purposes, and well adapted for the manufacture of warps.

Tuscan wool "Of Silesian and Austrian wools, several cases were noticed, but as their nature is so well known to the trade, it will be unnecessary to enlarge further on them.

Canadian wool. "The Tuscan wools presented no feature of usefulness to the worsted trade, and the Spanish wools, although well represented, are not of a class suitable to our trade.

"Of Canadian wools, Messrs Barber Brothers sent specimens well adapted for combing purposes. The deputation had not before seen any sample from our Canadian colony, and they think it probable that if the attention of the trade were drawn to this new source of supply, a large and mutually profitable business might arise from this favourable exposition.

"Before closing their remarks on this division of their labours, the Deputation beg to observe that, as far as wool is concerned, the superiority of the French merinos appear in a great measure to arise from the combination of their fine long wools for warp with colonial wool for weft."

Wool from Shanghai in China.

I may here mention China as a new source of wool. Some hundred bales sent from Shanghai have been lately sold in the English market.

Camels' hair.

Among the specimens of wool and of fabrics made from them, there was a small quantity of Camels' hair from Sindh, the produce probably of the country to the north-westward of the Indus. So extraordinary an effect having been produced by the introduction of alpaca-wool, which a few years ago was unknown to our manufacturers, it might be desirable to inquire if anything could be done with this. But the quantity procurable is said to be small, and much required by the people themselves. A cloak made of camels' hair was sufficiently fine in texture to look like merino, though differing much in being harsh to the feel. The coarser qualities of the wool are used for making very durable rugs.

Other animal products.

Besides the above, a variety of other animal products would afford materials for observation, but the foregoing have occu-

Fish oil.

pied a more than duly proportionate space and time. We have seen that fish oil is now becoming a regular article of export from India to England. The trade seems susceptible of great increase, as the natives of the coasts are already much occupied in carrying on a fishery for isinglass, sharks' fins,

Tallow, hides, and horns.

and for drying fish. Though the names are not known, there is no doubt that oil is obtained from others besides the shark. Tallow also is now imported, as well as hides and horns, all of which were unknown in commerce, when Mr. Colebrook wrote and recommended these for export whenever the freights became lower than in those days, when it was from 12*l.* to 18*l.*

Shell lac and lac dye.

per ton. I cannot, however, avoid noticing the products of one of the smaller animals though it has already been mentioned under the head of dyes, and that is the lac insect, and of which the other produce, shell lac, is now indispensable for making marine glue, now so extensively employed in most of the ships of the magnificent British navy. There might be a dread of the supply decreasing in proportion to the extension of cultivation, if it were not for the power which the natives have of spreading the insect, in the same way that the Mexicans do the cochineal. There will probably always be jungle enough at the foot of the various hills for the propagation of an insect, which is now doubly valuable for its dye rivalling cochineal, (v. Dyes, p. 87,) while its resin is required for a multitude of purposes besides that which has just been mentioned.

Pisciculture.

In connexion with the propagation of this insect, one is involuntarily led to think, of the admirable methods adopted by careful scientific observation for propagating various kinds of fishes, and now known as Pisciculture. This practice will

not only be valuable to all European nations but also to all their colonies.

DRUGS and PHARMACEUTICAL PRODUCTS.

As any view of the raw products of any general collection, without taking some notice of the interesting materia medica exhibited, would be incomplete, I propose making a few general observations on the drugs and Pharmaceutical products of the Paris Exhibition before concluding this already too extended report. These, perhaps, may be best noticed under two heads, because, with a few exceptions, Pharmaceutical products are only produced of a superior quality in countries where chemical science has made considerable progress: while Drugs, the produce of nature, will be best grown where the soil and climate are most suitable for elaborating the principles which make them useful as medicines. In noticing these, we must repeat the observation which was made at the beginning of this paper, that though the collections as such, must be judged of as shown at the Exhibition, the riches of the several countries represented cannot be so apprehended. Because the number and nature of the collections depend upon the fancy of individuals, who do not in general, like sending to distances, so well as exhibiting nearer home, unless there is a fair prospect of new markets. This will explain why there was a much larger number of Continental than of British Exhibitors in the department of Pharmacy, as well as the greater size of the collections of the former.

Pharmaceutical products from Great Britain.

The British exhibitors, for instance, were far from numerous, and their collections were small; in fact, they seemed to confine themselves to the things which they manufactured in large quantities, or in which they especially excelled, without attempting to make a general collection. Mr. Kent, of Stanton, was, however, distinguished by a good collection of indigenous materia medica, so excellently dried as to retain the natural colours as well of the flowers as of the leaves. In this, however, he was rivalled by M. Halbique of Caen. The vegetable extracts of the English exhibitors were remarkable for retaining the natural colour, odour, and taste of the several plants from which they were made, as shown by J. Bell and Co. and by Mr. Squire: the former also displayed excellent specimens of cod-liver oil, and the latter some choice chemicals. Mr. Morson exhibited some alkalies, including aconitine, for preparing which he is celebrated; Mr. Davenport, a good collection of salts of iron, &c., of morphia and quinine, and the acrid principles of ginger and capsicum; and Messrs. Smith, of Edinburgh, the newly separated principle Aloine. May and Baker displayed an excellent

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collection of pharmaceutical and chemical preparations, which some of the foreign Jurors especially noted for their cheapness: while Howard and Kent exhibited some of the finest samples in the Exhibition of sulphate of quinine, as well as of cinchonine and some vegetable acids, nitrate of silver and other pharmaceutical salts.

From north of Europe.

The collections from the north of Europe were generally small in extent, as the collections of excellent cod-liver oil from Norway. A pharmaceutical collection from Stockholm was not remarkable, nor were those from Holland; but Van Enst and Dyk exhibited oil of rhodium, distilled from the wood so named. C. Schmidt, of Bavaria, sent some well dried and cheap ergot of rye, *Secale cornutum*. Several exhibited

From Germany.

essential oils from Leipsic. Prussia was well represented by the excellent collection of Trommsdorf, conspicuous alike for its chemicals as for several vegetable principles, as well as by that of Fay and of Hermann. Austria sent the varied collection of Batka, of Prague, in which some of the less common metals were seen, and among the dried vegetables, the petals of the Arnica, separated from the other parts of the flower, were conspicuous for being well dried. The collection of Dr. Lamatsch, of Vienna, was remarkable for both its chemical and pharmaceutical preparations.

French pharmaceutical collections.

In France, the home of the Exhibition, and a country where both the science and the arts dependent upon chemistry are so well understood and succesfully practised, there was of course a large number of exhibitors, who displayed good specimens of their respective manufactures or excellent collections. Among the subjects of general interest, we may mention the award of a "Grande Medaille d'Honneur" to Aubergier for the cultivation of the poppy and the production of opium in France. The excellent drying of medicinal plants by some exhibitors has already been noticed. Many extracts prepared in vacuo were admirable, though those of the narcotic vegetables seemed inferior to those already noticed as sent from England. Among chemicals, the crude soda, with other products obtained from sea-weed, was well worth notice; as also the various preparations from the native nitrate of soda of Chili, and another collection of those obtained from bones. The several manufactures of quinine displayed, as might be expected, excellent specimens of the various salts of the cinchona alkalis. It was interesting to see the large masses of the new metal aluminium, as well as of sodium; for the production of the former has now given much encouragement to the preparation of the latter. The collection of Robiquet was rich in organic products, as that of Ménier in salts of morphia, fine powders, and preparations of barley.

while to the foreign Jurors the collection of Dorvault was conspicuous alike for its pharmaceutical preparations and its excellent selection of the rarer drugs.

The countries to the south did not display anything particularly interesting in materia medica. Tuscany, however, sent some essential oils and good specimens of iris root: the Pontifical States little if anything but castor-oil seeds. Spain exhibited barilla and the plants from which it is obtained, as well as some good extract of liquorice; while from Cuba there was what may be considered a good collection of drugs and pharmaceutical preparations sent by Dr. Sauto. New York and Canada both sent good specimens, and the latter a good collection, of essential oils. In the Indian collection there were specimens of several both alkaline and metallic salts made by the natives themselves, by processes with which they have been acquainted for ages, and the products of which they continue to employ in medicine, as well as in the arts of dyeing and of calico-printing.

Pharmaceutical products from south of Europe.

From Cuba.

New York and Canada.

From India.

In connexion with these pharmaceutical products, we may most suitably notice the various collections of drugs which were sent to the Exhibition; but, as has been already observed, generally from countries different from those which sent the former class of medicinal agents. This has, no doubt, been owing to the science of chemistry and the arts dependent on it, being in a less advanced state in the one than in the other. But nature has been so bountiful in her gifts, that the soil and climate of most of those which are warm regions, produce a variety of plants which secrete active and aromatic principles, in such variety and abundance as to make their products valuable as articles of commerce: either for employment as condiments, or for medicines, or for employment in the arts. Some of the collections were interesting, as enabling us to determine the sources from whence some articles known in commerce actually come. Others were vainly looked for, as the countries producing cinchonas, for instance, had sent no collections. Many of the others contained articles which were totally unknown, and distinguished only by native names, with sometimes a notice of the uses to which they were applied. To make such articles sufficiently interesting to excite the attention of competent observers, it is necessary that they should be accompanied either with the scientific name, or with specimens, of the plant producing it, and an account of the uses to which it is applied by the natives of the country. If this were not a subject too much neglected by professional men, who conceive that everything useful is contained in the Pharmacopœia, many of these questions might be resolved

Collections of Drugs.

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by the various medical men visiting the coasts or the interior of different countries. Yet this is a subject which should not be neglected by them, for it enables a medical officer, as I can vouch from experience, frequently being independent of European supplies, either when these fail, or he has to prescribe for disease, far from medical depôts and dispensaries.

Drugs from Toronto.

From the New World there were several collections, and among these a very good one from Professor Croft, of Toronto, with several essential oils from Lyman, of Montreal, and Giroux, of Quebec, and others from New York.

From Mexico.

Mexico sent a very interesting collection, among which there was a specimen of Winter's bark, and a fragrant wood called lign aloe, though the true ahila or aloes wood is a native of Silhet, Burmah, and Siam. There was also the kind of elemi yielded by the shrub, which from the specimens sent

Guatemala.

me I had named *Elaphrium elemiferum*. Guatemala forwarded a number of drugs with local Spanish names, but which were not referred to the plants whence they are ob-

Paraguay.

tained. Paraguay also contributed some unknown drugs, either with native names or with such as are known in Europe, but applied there, as, for instance, senna, to the leaves of different plants. Maté, however, or the leaves of *Ilex Paraguensis*, and used there as well as in many parts of South America as a substitute for tea and coffee, is now well

New Grenada.

known. New Grenada sent some specimens of the cinchona barks of its own produce, and which, though with local names, are well known from the subject having been so thoroughly

British Guiana.

studied. From the opposite side of the continent, that is, from British Guiana, there was a very extensive collection, in many cases well named, and illustrated by a printed catalogue. With some well-known drugs, there were others less so, and many astringents which might be used either as medicines or for tanning. Some native-grown pepper was

French Guiana.

also shown, as also from French Guiana, which also showed ichthyocolla or isinglass, with cinnamon bark, cloves, tonka beans, and vanilla; some of these were also shown from Mar-

Jamaica.

tinique and Guadeloupe. So the collection of Jamaica was extensive; proving the natural riches of the island and its capability of supplying a great variety of articles for commerce as well as for the support of its inhabitants.

Drugs from Algeria.

Returning to the Old World, we may first notice the French colony of Algeria, where opium, said to be of good quality in the proportion of morphia it contains, has been produced. From thence a collection of drugs was exhibited interesting both from the number of specimens, and from the French and scientific having been added to the Arab names,

Collection from an Arab physician.

and to a notice of the uses of the drugs. The whole was

sent by an Arab "Sid Mahommed Ben Chouar, Médecin, Alger." Few other products were shown from Africa, except from the west coast, as some sticky caoutchouc, also gum and copal, which we receive *viâ* Aden and India; and which were also seen in the Isle of Bourbon collection, as they may be imported either *viâ* India or direct from Africa. The contributions from the French colonies were, however, so mixed together that it was sometimes difficult to know to which of them a particular article belonged. Among these was shown a number of drugs from l'École de Pharmacie, collected at Pondicherry by M. l'Epine, Pharmacien of the Marine; many of these are necessarily the same as are in common use in the peninsula of India; but much time would be required to determine these, as an actual examination of specimens would be necessary, because many were without names. The Turkish collection of M. Della Sudda, which I have omitted to notice, would be an interesting object of study in connexion with African and Indian collections, because many of the articles exhibited in 1851 I know were undoubtedly the produce of India. I myself exhibited in London, in 1851, a very large collection, amounting in all to about 1,000 specimens, of the mineral, vegetable, and animal substances used as drugs in different parts of India, but the manuscript in which they are noted and partly described, and which would lend some assistance in such an examination, still remains unpublished.

Other French colonies.

Turkish collection.

The Indian collection of the late Exhibition was rich in the various natural and partially manufactured articles which are used by the natives, or likely to be useful in the various arts and manufactures of Europe. They are interesting therefore to commerce. Some of the most important of these have already been noticed, others it would be out of place to describe on the present occasion. The collection of pure materia medica, or of substances used solely in medicine, was less extensive. But it was selected with a view to prove what a number of drugs, available for the various objects required to be effected by a complete and efficient materia medica, are within the reach of medical officers in India. Some, however, have been selected because they were interesting from their historical associations, as they undoubtedly formed articles of the materia medica of the Greeks, and must therefore have been included in the commerce of the ancient world. To these were added a number of drugs from Scinde and Travancore, as well as from Madras, which it was impossible to exhibit properly, partly from the want of space and partly because they arrived late. But also because they were sent without any but the native

Indian collection.

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names, which are often unintelligible even to those studying the subject, in consequence of the number of languages in use in different parts of India, and therefore requiring for their full elucidation, much time, and a polyglot catalogue. This may be prepared as the several articles are studied.

Ceylon.

Many of the same things are shown in Ceylon as in India, as well as in the collection from the Dutch possessions in the Eastern Archipelago, which, though composed of much larger specimens, did not contain many articles which were not exhibited in the great Indian collection, as this contained products and articles of commerce from countries extending from Singapore to the Punjab.

Dutch Possessions.

Having, my Lord, taken a general view of the different classes of substances to which I have myself paid attention, and which, or some of them at least, appear to be not only of commercial but of general public interest, I fear, though wishing much to avoid doing so, I may have encroached upon the province of other Jurors. I have, therefore, in most instances confined myself to illustrating Indian subjects, as the information respecting these is not generally well known. But as in so doing I am well aware, from the number of substances treated of, that I have transgressed the limits to which such a report should be confined, I have to request your Lordship's consideration, and hope that you may ascribe it to my desire to do justice to the commission with which I have been honoured.

I have, &c.

J. Forbes Royle, M.D., F.R.S.,
late President of the Jury of Class XII.

On Civil Construction, being Class XIV., by Captain Fowke, Royal Engineers.

To the Right Honourable the Lord Stanley of Alderley, President of the Board of Trade, &c., &c.

My Lord,

In accordance with your instructions, I have the honour to submit to your Lordship the following Report on Civil Construction, as represented in the Paris Universal Exhibition.

System of classification.

In examining the arrangement of the system of classification adopted by the Imperial Commission, we find that the fourteenth class begins with the enumeration of materials used in building and civil construction in general; this is the principle throughout the entire classification, viz., to commence with the raw materials, followed by the tools and apparatus used in their manufacture, the concluding part being reserved for the results of such manufacture. Such an arrangement would seem peculiarly happy in the present case, as the nature of the building materials in common use in different parts of the world has always exercised an important influence over the character and nature of the constructions of which they form a part, so much so as, in fact, to influence in a great degree the system and feeling of national architecture, so that we have the ponderous massiveness of Egypt, the stern grandeur of Greece, and the classic elegance of Rome, all the offspring of a hard enduring material, more or less stubborn under the chisel and mallet. The more manageable materials in use in the middle ages were undoubtedly instrumental in producing a change in the nature of the constructions of the period, and probably to such accidents of place and circumstance are we indebted for many of those beautiful and fantastic forms which delight us as much by their delicacy of execution, as by their hardihood of design, and in which the architect, adapting his work to the materials at his disposal, has atoned for his departure from the severe outline and imposing masses of classic architecture, by the introduction of a charm to which his sterner predecessors were strangers.

In our own time, in newly settled countries, such as America and many of our colonies where wood is abundant, and stone is either difficult to be obtained, or expensive from

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the scarcity of labour, we find a different kind of construction springing up, often picturesque in appearance, and exhibiting much talent in design, but especially creditable for its simplicity and ready adaptations; at the same time its ephemeral and temporary character cannot fail to give it more or less an air of insecurity and want of strength, however unmerited. Finally, we come to that period which has with truth been called the age of iron, in which a total change of material has effected as great an alteration in the constructions into which it enters, rendering simple, feats of construction which it would have been folly to have attempted in any of the previous periods; and of the facilities which are afforded by the use of this material for covering large areas with economy and quickness, no better illustration can be given than the buildings which have been erected for the two great Exhibitions of London and Paris.

Section 1.

First in the list of materials we come to stones, marbles, and slates of various kinds, exhibited either as specimens of the quarries from which they have been extracted or under the forms in which they are known in commerce, as appertaining to different species of employment in the arts of construction.

Building stones: England.

From England we have a collection of the building stones of Cornwall, contributed by the Royal Commissioners for the Exhibition of 1851, and some beautiful specimens of serpentine from the same county, and examples of granite capable of a high degree of polish from Aberdeen; but the Bristol and Bath stone, the Portland quarries, the Yorkshire sandstone, Scotch freestone, and the numerous and valuable slate quarries of Devonshire and Ireland, are entirely unrepresented. Some remarkable samples of green Connemara marble are exhibited by Mr. John Costello in the form of a table and chimney-piece, and there are two exhibitors of roofing slates from Carnarvonshire, who send good specimens, and we have a specimen of the granite which is now being used in the construction of new Westminster Bridge, sent by the Cheesewring Granite Company of Dartmoor. A beautiful decorative material, contributed by Mr. Magnus of Pimlico, although having slate for its basis, can scarcely be said to come under the head of building materials in their unmanufactured state, and besides it has been so ably described under the head of decoration by Mr. Digby Wyatt that it would be superfluous to do more than notice it in this report.

Building stones: British Colonies.

From the British Colonies are sent several very complete and perfect series of building stones. Canada has a collection exhibited and arranged by the geological survey, from which it would seem that the prevalence of wooden buildings in that

country is by no means to be attributed to any want of more permanent material. Specimens of basalt, sandstone, serpentine, granite, and white and red marble, the products of the colony of New South Wales, are contributed by the Rev. W. B. Clarke, of Sydney, but more as geological specimens than in reference to their merits as stones of construction, and unaccompanied by any description either as to their capabilities in this respect, or to the readiness with which they can be obtained for building purposes. In the same category may be included some specimens of granite from British Guiana, and calcareous stones, limestone, steatite, and marbles from Jamaica. Specimens of building stone are sent from Van Diemen's Land, and examples of the same class form part of the valuable collection of the rocks, ores, and fossils of Victoria, contributed by Captain Clarke, Royal Engineers; these, with some samples of the curious material called flexible sandstone, and also of Chunar marble in the Indian Collection, complete the Exhibition of the building stones of the British Empire.

Building stones: France.

France is extremely rich in this material, and much of the architectural beauty of Paris is undoubtedly to be accounted for by the possession of inexhaustible quarries of a beautiful building stone, of an extremely enduring quality, and at the same time so even of texture, and so easily wrought as to be capable of receiving every variety of ornament. The building stones of Normandy are also justly renowned, and several of the most celebrated quarries of Caen are represented at the Exhibition under the names of Fontenay stone, Aubigny stone, &c., and strange to say, the best specimen of this material, viz., Caen stone, is exhibited by an English firm, Messrs. Gates and George, who have sent an exquisitely carved altar, reredos, and doorway, which do credit to their workmanship, and at the same time serve as admirable illustrations of the capabilities of Caen stone for the more delicate descriptions of carving, appertaining more especially to works of a mediæval character. A good sample of a peculiarly hard red sandstone from the department of the Vosges, is found in the dado which forms the lower part of the external walls of the Palais de l'Industrie, where its colour is introduced with good effect in contrast to the paler Parisian stone with which the remaining parts of the building are constructed.

There are, besides, between twenty and thirty different exhibitors of stone, marble, and slate, from all parts of France and Algeria, by far the greater number of whom contribute marbles in either rough blocks or worked up into ornamental articles or forms. Roofing slates are also sent by many persons, almost all the specimens being very much thinner

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than those made use of in this country, where this kind of covering is more popular than in France; in fact, the greatest objection made by French builders to the employment of slate as a covering is, that it will not bear the weight of any workman who may be sent on the roof for the purpose of repair, and this objection, which appears at first sight absurd, is easily understood when the samples of French roofing slate are examined. The very general employment of tiles, and more recently of zinc has, however, divested the slate trade in France of the important place which it holds in this country among arts appertaining to construction. In the numberless forms in which we see slate every day used in England, such as in flooring, cisterns, the fittings up of water-closets and other conveniences at railway stations, &c. it seems almost if not totally unknown in France, and some slate slabs for pavement, for floors, a billiard table, and a garden seat of the same material from Angers, are quite novelties to the Parisian constructors, while a stair with slate treads exhibited by Messrs. Valiguir and Co., is looked upon as a discovery. Some very fine collections of the marbles of different districts of France are seen in the Annexe, but all of such very small sizes, and set in such a way that no opinion can be formed of either their general character or the dimensions of which they can be obtained. In the Algerian Collection appears a very handsome chimney piece, as well as some detached slabs of an exceedingly delicately marked and beautifully tinted Oriental alabaster, the product of that colony, and some similar specimens, but inferior in size and colour, among the Turkish productions. This beautiful white translucent marble is quarried in the province of Oran in Algeria, at a distance of only two miles from the sea, and as it can be obtained in blocks of considerable size, and delivered at the cost at from 17*s.* to 21*s.* the cubic foot, we may hope ere long to see it brought into use as a material for internal decoration. Algeria shows several other kinds of marble, alabaster, porphyry, and granite, and of these many are said to have the advantage of being found close to the coast. From Tuscany we have, from the collection of the Royal Polytechnic Institution of Florence, specimens of the marbles for which she has long been famous, such as the yellow sienna, the travertine, the macigno, and other well-known names. And Greece also sends us some of her anciently renowned Pentelicon, green porphyry, and "rouge antique."

Building stones: Wurtemburg.

The most perfect and complete collection of building stones in the Exhibition is undoubtedly that sent by Wagner of Stuttgard, and exhibited among the Wurtemburg raw produce; they are cut in neat blocks, and arranged like an

octagonal gatepost, and in the order of their geological formation. They are accompanied by a description of each specimen, which adds to their value as a collection, and which is therefore given in English as follows:—

No. 1. Granite from Roethenberg, used for the great column before the Palace at Stuttgard.

No. 2. Granite from Euzklösterle, near Wildbad, used for Schiller's monument at Stuttgard; power of resistance to crushing weight, 7,917 lbs. per cubic inch.

Nos. 3, 4, and 5. Granites. No. 4 very fine grained, from the valley of the Murg.

All these granites are fit for monumental constructions. General specific gravity, 2·64.

No. 6. New red sandstone from Schramburg.

No. 7. Ditto from Hausen, of a dark red colour, frequently used for monuments.

No. 8. Ditto from Fiédrichsthal, used as a fire-proof material for the inside lining of furnaces.

Nos. 9, 10, 11. Ditto from Freudenstadt.

All these sandstones come from the Black Forest, and the large blocks fetch good prices. They are well adapted for building purposes on account of their hardness and being readily wrought; they also resist change of temperature. They are obtained in large blocks and in flakes of a large size. The detached blocks and the quarry stones of a coarser grain yield very large millstones; the finer sorts are used as grindstones. The specific gravity is 2·22 to 2·36, the finer grained sorts being the heaviest.

No. 12. Limestone from Friédrichsthal, used for building and paving stone. Its specific gravity is 2·76, and power of resistance to a crushing weight, 8,687 lbs. on the cubic inch.

No. 13. Dolomite from Rothwiel, building stone for indoor work. Specific gravity, 2·26.

No. 14. Sandstone of the red marl, near Ludwigsberg. Power of resistance to a crushing weight, 4,979 lbs. on the cubic inch.

No. 15. Ditto in laminæ or flags.

No. 16. Ditto, secondary from Stuttgard. Power of resistance to a crushing weight, 7,635lbs. on the cubic inch.

No. 17. Ditto, secondary from Maulbronn. Power of resistance to a crushing weight, 7,476 lbs. on the cubic inch.

No. 18. Ditto, secondary from Mühlhausen. Power of resistance to a crushing weight, 5,128 lbs. on the cubic inch.

No. 19. Ditto from Gerlingen, near Leonberg. Power of resistance to a crushing weight, 6,740 lbs. on the cubic inch.

All these sandstones occur in blocks of large dimensions, and also in large flags; they are excellent stones for building on account of their fine grain and the ease with which they can be wrought. The white varieties are frequently employed for sculpture, and also for grindstones. Their specific gravity is from 2·14 to 2·28.

No. 20. Sandstone from the superior strata (called Stubensanstein) coarse grain, from Schlaydorf, near Tübingen, first quality.

No. 21. Ditto, Stuttgard.

The two last-named sandstones occur in blocks of very large size, but rarely in flags. The meeting of German architects, in 1854, pronounced this stone to be one of the best materials known for building purposes. The exterior walls, as well as most of the sculptures of Cologne Cathedral, are of this stone, great quantities of which are still transported there on the Neckar and Rhine. This stone never decomposes, nor does any vegetation grow on its surface, as it does not contain any earthy matter; it maintains its light grey colour, resists the heat and cold, bears a heavy weight, and is easily cut without injuring the health of the workmen. Several churches built of the same stone in the thirteenth century are now in good preservation, thus proving its power of resisting the destructive influence of time. It thus shows all the advantages of granite. The best quality is found in the neighbourhood of Tübingen and Nürtingen.

It is also used for different sorts of millstones, according to the fineness of the grain. It surpasses the English stones used for husking rice, and makes excellent grindstones. Its specific gravity is 2·02, and its power of resistance to a crushing weight, 2,095 lbs. on a cubic inch.

Nos. 22 and 23. Lias-sandstone, from Plieningen and Göppingen, both sorts used as building stones. Their specific gravity is 2·1, and their power of resistance to a crushing weight, 3,856 lbs. on the cubic inch.

No. 24. Lias limestone from Vaibingen, near Stuttgard, used as paving stone. Specific gravity, 2·74.

No. 25. Lias slate from Zell, used for table-tops and floors, chiefly for its large dimensions and low price.

No. 26. Sandstone of the lower oölite from the brown jura of Aalen, fire-proof, used in lining furnaces. Specific gravity 1·96.

No. 27. Dolomite, from the white jura of Urspring, near Ulm. Building stone. Specific gravity 2·74.

No. 28. Saccharoide limestone of the coralline oölite of the the white jura, Arnegg. In the valley of the Blau river this stone is met with in very large blocks; it is extremely solid, and is used for paving and building. Its specific gravity is 2·42, and its power of resistance to a crushing weight is 6,663 lbs. on the cubic inch.

No. 29. Limestone from the coraline oölite from Schmaitheim, Heidenheim, used as building stone for in-door work. Specific gravity, 2·48.

No. 30. Fresh-water marble, red, from Böttingen, near Münnsingen.

No. 31. Marble of the Oxford clay, yellow, from near Kircheim.

No. 32. Ditto, grey, from Ochseerwang, near Kircheim.

No. 33. Ditto, yellow, from near Zwiefalten.

All these marbles are susceptible of a high polish, and are often employed for ornamental work. Specific gravity, 2·72.

No. 34. Limestone of the coraline oölite from near Ulm. Building stone.

No. 35. Ditto, flag.

No. 36. Lithographic stone of the same formation, from Kolbingen, near Tuttlingen, chiefly used for polished table-tops and flooring. Specific gravity of Nos. 34, 35, 36, 2·46.

No. 37. Molasse, from near Wiblingen, building stone of inferior quality. Specific gravity, 2·16. Power of resistance to a crushing weight, 687 lbs. per cubic inch.

No. 38. Fresh-water limestone from the tertiary formation from near Ulm, very good building stone. Specific gravity, 2·52.

No. 39. Limestone, fresh-water deposits from Geislingen, remarkable for its lightness and great resistance to the influence of the air. When first quarried it is sawn with a common handsaw; it hardens on exposure to the air, and bears a heavy weight. The stone has been employed in building very high church spires, for the arches of railway viaducts, and for fortifications. Its specific gravity is only 1·48, and its power of resistance to a crushing weight from 600 lbs. to 1,000 lbs. per cubic inch.

No. 40. Limestone of the diluvial beds from Unterturkheim, near Caunstatt, used as a building stone. Specific gravity 2·14. Power of resistance to a crushing weight, 873 lbs. per cubic inch.

No. 41. Ditto, fresh-water deposit from Seeburg, same quality as No. 39.

Besides this collection there are some of the finials and other ornamental work intended for Cologne Cathedral in

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the great nave, which show in a remarkable degree the beauty of the Stubensandstein, it appears to take an extremely sharp arris, and to work with great ease into the most elaborate forms, and these qualities, together with its delicate tint of clear whitish grey, which it is said to keep for any length of time, seem to render it most valuable for constructive purposes, more so apparently than any stone with which we are acquainted.

Specimens of stone: Belgium.

Belgium exhibits some porphyries, but not for building purposes, they being intended for paving stones, and shown in that form; some of the same stone is also shown broken up for macadamizing roads, and is the only specimen of this material in the Exhibition, the contributor is M. Tacquenier, of Lessines. Several specimens of marble and stone from the same country are exhibited both in the raw state, and also wrought into various ornamental articles, such as table-tops, and chimney-pieces, &c. The prices of some of the Belgian marble chimney-pices are so low as to defy all competition from this country, where the necessary labour alone could not be obtained for the sum demanded for the finished article; the workmanship and finish of these cheap articles is manifestly very inferior, and numberless tricks of trade, such, for instance, as getting up the surface by French polishing, are said to be resorted to. Among the varieties are a good black marble from Namur, white marble and red marble from Hainault, all in the form of chimney-pieces, and a great slab of dark slate-coloured or black marble about 14 feet by 6 feet, having its surface covered with heraldic ornament in bas-relief, but for what purpose it is intended it is impossible to form a conjecture.

The classification, after mentioning building stones, proceeds to the enumeration of other articles or materials of construction in the following order.

Cements, mortars, &c.

Limes, cements, hydraulic limes in their different stages of preparation, artificial hydraulic limes, puzzolanas, sand, &c.

Mortars and concretes, including various methods of composition and machines for its manufacture.

Plasters, plasters mixed with alum, plasters mixed with silica, stuccos.

Before entering into the consideration of these subjects, it is necessary to notice one, which, strange to say, appears to have been omitted from the French system of classification, unless, indeed, it may be found under the head of some other class, as is of not unfrequent occurrence in that work, where its practicability and usefulness are often sacrificed to its philosophical arrangement. The subject of artificial stone is one which is thus omitted, and which being represented by several exhibitors may, perhaps, be introduced with pro-

Artificial stone.

priety into the present section, taking as it does a middle rank between natural stone and cements, and being generally composed of one or both of these ingredients in different proportions, and treated in various ways. The term artificial stone is used in connexion with the many different kinds of cements and compounds that have been from time to time brought forward as substitutes for stone as a building material, and more especially with a view to the saving of the costly labour necessary in reducing the raw material to the ornamental forms required for architectural decoration; many of the substances known by that name differ from cements only in their application, and in being moulded beforehand, and used in building in blocks in a hard state, and they may be said to be distinguished from the kind of material known as terra-cotta in being a chemical combination of the ingredients of which they are composed effected without the aid of heat. In one case, indeed, which is represented in the Exhibition under the epithet of artificial stone, heat has been employed to a great extent, namely, in the great block of semi-vitrified brick or clinker, contributed by M. Borend, and more fully described further on. And in the case of Mr. Ransome's artificial stone, which is, perhaps, the one that most of all the various attempts really deserves this epithet, the chemical combination can only be effected by the aid of great heat.

M. Kuhlmann's process for hardening stone.

The nearest approach to Mr. Ransome's process in the Exhibition seems to be that of M. Kuhlmann, who exhibits specimens of his method of saturating soft and friable stones with silicate of potash, so as to render them hard and permanent, and not only to improve in this respect the building stones already in use, but to enable what has hitherto been thrown aside as quarry rubbish, from its softness, to be made use of in a state in which it is harder and less liable to deterioration than the naturally firmer and more valuable beds. Another obvious advantage attending the employment of this process, is that the softest stones may be wrought into the most delicate forms, and then submitted to the action of the silicate of potassium, thus saving the expense of the labour in cutting, which the harder qualities necessitate. Several experiments that have already been made on this process are said to have been attended (as far as can be judged of without the effect of time) with entire success, and the cost of silicatizing the face of a wall is stated not to exceed from 1*d.* to 1½*d.* the superficial foot. The operation consists in simply saturating the stone with the liquid made use of until it is no longer capable of imbibing moisture, and the colour, although at first much changed, is eventually not injured.

M. Dumesnil's artificial stone.

Among the many exhibitors of artificial stone who appear in the French section (and, indeed, France is the only con-

Capt. Fowke on Civil Construction.

tributor under this head), a M. Dumesnil, accompanies some blocks of artificial stone with a kind of estimate of the comparative expenses of construction with brick, rubble, and ashlar masonry, and also with his artificial stone, which he makes out to be in the following proportions:—

	£
Front exterior, complete in ashlar masonry -	1,114
The same elevation in brick - - - -	827
The same in rubble masonry - - - -	560
The same in artificial stone - - - -	480

No data are given on which these sums are founded, and knowing the extremely favourable eye with which inventors are apt to regard their own inventions, they would of course be received with caution; his manufacture has, it is said, been in use with some success for several years; it seems to be principally composed of plaster of Paris, and is cast in moulds into any shape.

M. Coignet's Beton pisé.

A M. Coignet exhibits a block of the concrete which he has used in the construction of a house near St. Denis, and which has excited considerable interest in Paris. M. Coignet has, as the results of a series of experiments, given us the recipes for making two kinds of concrete suitable for house building, which he distinguishes by the epithets of economic concrete, and hard and solid concrete. The first is composed of—

Sand, gravel, and pebbles - -	7 parts.
Argillaceous earth - - -	3 parts.
Quick lime - - - -	1 part.

This concrete, he says, properly beaten up and mixed, has given walls nearly as hard as the common soft rubble masonry used in Paris; in price it competes with ordinary pisé work, over which, however, it has the advantage of being able to resist moisture.

The hard concrete is composed of—

Sand, gravel, and pebbles - -	8 parts.
Common earth, burnt and powdered	1 part.
Cinders, powdered - - -	1 part.
Unslaked hydraulic lime - -	$1\frac{1}{2}$ parts.

The materials to be perfectly beaten up together. Their mixture gives a concrete which sets almost immediately, and becomes in a few days extremely hard and solid, which property may be still further increased by the addition of a small quantity, say one part, of cement; and the price, depending principally on that of the time and labour, was, in Paris, under unfavourable circumstances, $3\frac{1}{2}d.$ to $4d.$ per cubic foot; with more favourable conditions, $2d.$ per cubic foot. A house, three stories in height, 65 feet × 45 feet, standing on

a terrace having a perpendicular retaining wall 200 feet in length and 20 feet high, has been actually constructed, with every part, including foundations, vaults of cellars, retaining wall, all walls exterior and interior, without exception, of this hard concrete (Beton Dur), as well as the cornice, mouldings, string courses, balustrades, and parapets, and without bond iron, lintels, or wood throughout; the use of plaster in the interior is also avoided, as the concrete takes a surface sufficiently fine for papering. The retaining wall measures 22,750 cubic feet of masonry, and constructed of Paris hard rubble (meuliéres) or ashlar, it would have cost from 1,200*l.* to 1,500*l.*, and in common soft rubble (moëllons) and stone coping, from 650*l.* to 750*l.*; on M. Coignet's principle it has cost—

	£
22,750 cubic feet of concrete laid at 2*d.* per cubic foot - - - - - -	190
Balustrade in moulded concrete - - -	18
Total -	£208

The entire house, M. Coignet says, only cost 400*l.*, and he further states that to build one similar of ashlar it would have cost probably five times that amount; the same person has also constructed a chemical manufactory at St. Denis, in which walls, drains, and water-pipes are all of this material, as also the foundation of a 30-horse engine. If all these statements as to cost, &c., are correct, the material of M. Coignet would appear worthy of being further inquired into, as it would seem to afford a means of construction at a price hitherto unheard of.

Another description of artificial stone, a large block of which is exhibited by a M. Berand, comes rather under the head of brick than artificial stone, as it is procured by the application of fire, and is, in fact, simply an enormous mass of brick; it is proposed as a substitute for stone in sea walls and other maritime constructions, where the superior durability of vitrified material will give it an advantage over concretes made with lime or hydraulic cements; it ranks in the same class of materials with the slag cast into blocks and proposed as a building material by Mr. Chance, of Birmingham, and it is much to be regretted that both he and Mr. Ransome should have abstained from exhibiting in this class, as the artificial stone of the latter gentleman is certainly far superior to anything of the kind in the Exhibition.

M. Berand's artificial stone.

Before quitting the subject of building stones, it must not be omitted to notice the stone of which the Palais de l'Industrie itself is constructed, and which was quarried in

Soisson stone.

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the neighbourhood of Soissons, about 70 miles from Paris; it bears the name of Villars-la-Fosse, from the quarry from which it is extracted, and has been employed largely in the construction of the new galleries of the Louvre, in the repairs of the Palace of the Elysée Napoléon, and several other public works, and seems likely to become popular with the architects of Paris, as from the quarries being within three or four miles of the river Aisne, a branch of the Oise, and also within a tolerably easy distance of the Chemin de fer du Nord, it can be brought to Paris easily and cheaply; its price in the quarry is 7*d.* per cubic foot for blocks not exceeding 20 inches cube; 8*d.* per cubic foot for blocks up to 40 inches cube; 9½*d.* per cubic foot up to 60 inches cube; and 11½*d.* per cubic foot up to 80 inches cube; at Paris the price of the last-mentioned is about 1*s.* 7*d.* the cubic foot; its capability of resistance to crushing is very great, in some experiments it having borne as much as 3½ tons on the square inch, for which reason it is in great repute for foundations and substructures.

The next subject we come to is that of cements and limes, of which there are an immense number in the Exhibition, but as in most cases, the samples are extremely small, and already set, it is impossible to form an opinion upon their qualities, except where they are accompanied by analysis and statements of their merits, which, after all, is an unsatisfactory way of deciding upon the comparative merits of different objects of the same kind, and it is much to be regretted that such an opportunity was lost of making satisfactory and full trials of all the limes and cements exhibited; an attempt by some of the Jurors of Class XIV. to institute a series of experiments of this kind either failed altogether, or was only partially carried out, from want of sufficient quantities of the cements in their unslacked state having been sent by the various exhibitors; owing to this cause, none of the limes or cements sent from England were examined at all. The lime which was most favourably mentioned was a new one, known by the name of Chaux d'Echoisy, the manufacture of M. Jugand Roux, of Augoulême, and of which the following analysis is given:—

Analysis of the Chaux d'Echoisy.

Carbonate of lime	803·0
Carbonate of magnesia	26·0
Carbonate of protoxide of iron	5·8
Alkali	1·2
Pyrites	8·0
Clay	146·0
Bitumen	10·0
	1000·0

It is said to be unaffected by the action of salt water, but of this some time is necessary to judge.

The next materials we come to in the classification are pottery employed in the construction of buildings, including roofing tiles, bricks, hollow bricks, and terra-cotta pipes.

Tiles in five classes.

The several descriptions of roofing tiles shown in the Paris Exhibition, almost all of which are from France itself, may be considered as belonging to one of five different classes, the first of which includes the original flat tile, the examples of which differ merely in the material of which they are composed, and in their greater or less thickness and weight, governed in great measure by such material. The other four classes or general forms of tile are the results of different attempts which have been made from time to time to obviate the great objection to the employment of flat tiles, namely the necessity of laying them so that the roof is covered at every part of its surface with three thicknesses of tile, and the consequent enormous weight of this description of covering, an evil so great as to have almost entirely banished it from all large modern structures in this country, as more than counterbalancing its undoubted and great advantages of durability, great strength, resistance to the action of the wind, cheapness, and perhaps the most important of all, the fact of its being so bad a conductor of heat as to render the attics of buildings thus covered, less sensible of the extremes of heat and cold, which are so much felt where metal or even slate is employed.

First class: Burgundy tiles.

The best specimens of the flat or Burgundian tiles, (as they are termed in France,) in the Exhibition are perhaps those of Messrs. Genot and Co., to which they give the name of grès cérame. In appearance they are almost like fine grained granite, with a very metallic ring, extremely thin and light, and no doubt of great strength and durability. A somewhat similar tile, from the factory of M. Boulanger, of Auneuil (Oisi), if anything surpasses the first-named in thinness and lightness; in both, the clay is completely vitrified, and it is a pity that some particulars as to weight, price, &c., of such a remarkable material have not been sent with them. It may be mentioned here that Messrs. Genot exhibit draining tiles and pipes of the same excellent material. The average weight of the flat tile may be taken at upwards of 5,000 lbs. the thousand, 380 tiles to the square of roofing, which thus weighs from 1,800 to 2,000 lbs. in this material.

Second class.

The flat tile is kept in its place by pegs or nails driven through holes in its upper part, and each tile is by this means attached to the lath without being dependent on its neighbours for support; the same rule applies to the next class, which is, as well as the first, flat, and attached in the same

way, and in which the attempt to reduce the weight consists merely in cutting away those parts of the tile which are concealed beneath others, and in some cases also in rounding off or pointing the exposed part, so as at the same time to contribute more or less to its ornamental character; the result is a tile somewhat in the shape of the blade of a shovel flattened, and in some cases approaching the form of the spade pip on cards, and which is fastened, as in the flat tile, by a peg driven through a hole in the short stalk or handle at its upper extremity; these tiles are further ornamented in many cases by the introduction of figures or patterns in relief on their surface; they have the advantage of being easily fixed, and lighter than the plain flat tile, but still necessitate a very high pitch of roof to enable the laps to be perfectly weather-proof. The first departure from the ordinary Burgundian pattern is illustrated by the tiles exhibited by M. Blondeau, which are merely the former with the lower corners rounded off, and a little scoop at each side taken out of the part which is hidden by the superposed tiles. Some of these tiles are more or less ornamented in relief on the surface, and when fixed have a very pretty effect. They appear to have been gradually pared away by different makers till they have assumed the form described above as that of the spade pip on a card, which seems to be the one generally in vogue among the French and Belgian makers. Belgium sends, by M. Josson, of Antwerp, some good examples of this class of tile, the weight of which is stated to be 3,740 lbs., and the cost 60*s.* per thousand; 220 of these tiles cover a square of roofing, the weight of which is therefore 812 lbs., which gives a remarkable difference in their favour in comparing them with the Burgundian tile; their price in Belgium is 60*s.* the thousand, or 20*s.* the square, fixed. Similar tiles are exhibited by many French makers; among them may be noticed those of M. Vaultrin, which only seem to differ from those described above in being larger and cheaper, the tiles costing from 55*s.* to 110*s.* per thousand according to size, the square taking but 140 of the larger, and costing only 13*s.* A M. Martin, of Bourbonne les Bains, also exhibited specimens of a similar tile, but of which no particulars as to price or weight are given.

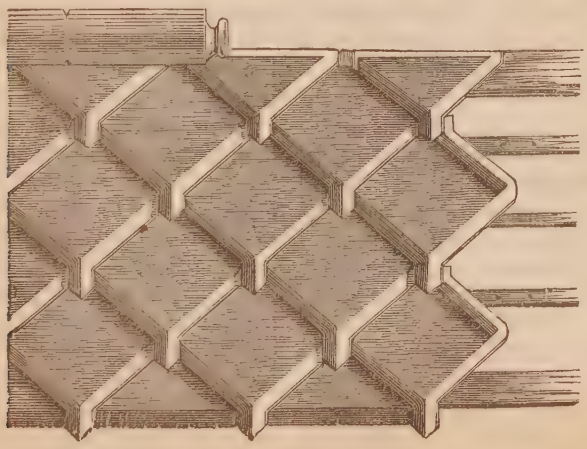
The desire to remedy the obvious disadvantages resulting from the long overlapping joint and high pitched roof, the necessary consequences of the two descriptions of tile just mentioned, has induced makers to resort to the construction of several varieties of tile, the general principle of which is to substitute for the lap a short vertical joint rendering the lap and high pitch unnecessary, and at the same time connecting the tiles so firmly together that they

are not wholly dependent on their hold on the laths for being kept in their position; these objects are attained in different ways, which, however, all unite in the employment of tiles having their edges turned alternately up and down, so as to form vertical joints at their junction, instead of only overlapping each other as in the first two cases just described, and the remaining classes merely differ in their mode of carrying out this improvement; and, first of all, we have what may be called a third class in the common pantile so much used in London, which is made in such a form that the tiles in each separate course make such a joint with each other, but without reference to the course immediately above or below them; this mode gets rid of the difficulty of providing a great amount of lap for the longitudinal joints, but leaves the horizontal still untouched, and still therefore necessitates a considerable overlap and a high pitch of roof.

Third class pantile.

In the fourth class we have the edges inclosing one angle of the tile turned up, and the remaining two down, and the tile laid, so that the angle first-mentioned shall be uppermost, and that the joints shall run in a diagonal direction, by this means continuing the vertical lap all round the tile, which thus enables it to be employed at a much less inclination, and with so little overlap as to have only one-sixth of the surface hidden or useless for purposes of actual covering; in this tile the peg is also dispensed with as a mode of fastening, the tile having a small projection on the back at its upper part, by which it is attached to the lath, a slight increase of projection in the ledge at the lower angle, which fits into a corresponding depression in the tile next below, serving still further to secure each in its place. This class may be subdivided into such tiles as are square, and those that are lozenge-shaped; of these, the former,

Fourth class.



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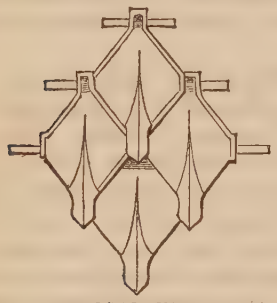
known as the tile Courtois from the name of its inventor, is perhaps the most simple, while the lozenge-shape gives more scope for the introduction of ornament; the square tile has also the advantage of having a less length of joint in proportion to its length, and consequently of having rather more of its surface exposed than the lozenge.

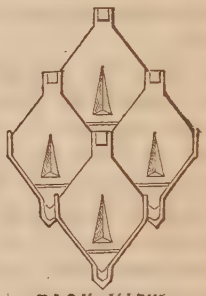
M. Courtois' tiles.

Each one of the tile Courtois weighs 4·5 lbs., and 180 of them are required for a square of 100 superficial feet, so that the weight of this amount of covering would be 810 lbs., and its cost 44*s.*

One of the principal exhibitors of the lozenge tile of



FRONT VIEW.



BACK VIEW.

M. Burdin.

this classis M. Burdin, of Lyons, whose tile is strengthened by a slight rib along its centre, which adds materially to its ornamental appearance, and enables it to be made extremely thin and light, the square of this description of tiling not amounting to more than 770 lbs., and the single tile being 5·1 lbs.; it is shown in three dimensions, running 150, 250, and 350 tiles to the square, and costing respectively 6*l.*, 3*l.* 12*s.* 6*d.*, and 3*l.* 4*s.* the thousand tiles, or for the first two, 18*s.* the square, and for No. 3, 22*s.* 6*d.* Another maker, a M. Gaillard de Romanet, also from Lyons, exhibits a tile identical in principle with that just described, but with greater pretensions in the way of ornament; in this tile the small strengthening fillet is developed into a grotesque bird's head, something approaching to the grotesque gurgoyles so often seen in mediæval structures, which is remarkably pretty in the hand, or when seen close, but is altogether so insignificant in size, and so wanting in boldness, as to be utterly thrown away at even the lowest height of a roof in actual construction; these tiles are shown as laid alternately, white and red, and although, as before mentioned, the ornament must be considered as so much waste, yet the whole effect in a roof must be pleasing and light.

Fifth class.

The fifth class of tiles may be considered as only differing in principle from the tile Courtois in having the tiles

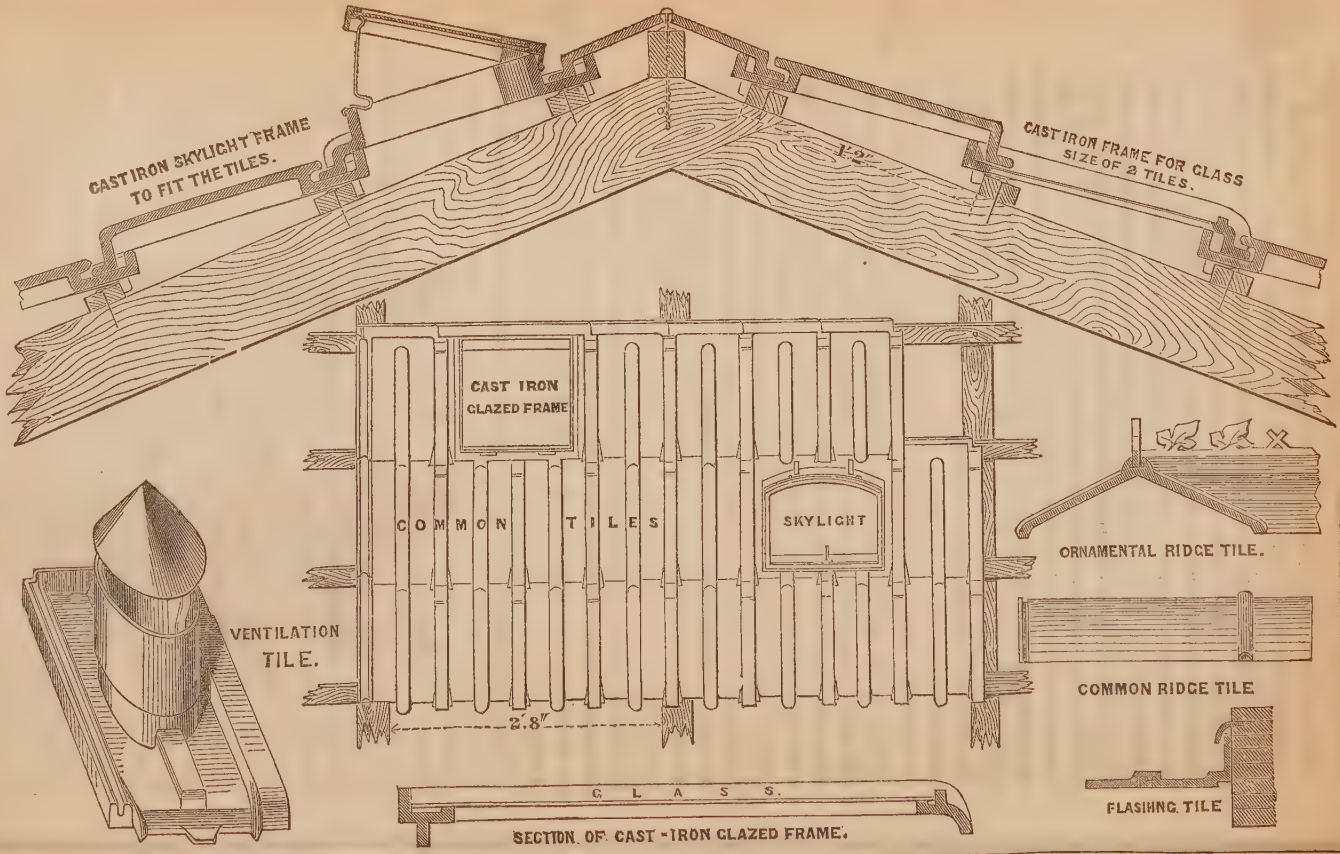
laid with their joints horizontal and vertical instead of diagonally, and consequently having the turned-up edge carried along the top and one side, and that turned down along the other side and the bottom; but so many modifications have been introduced, that in many of those exhibited the original or governing form is with difficulty discovered. This class, as well as the last, may be said to consist of two subdivisions, differing in the manner in which the tiles are laid; that is, whether the vertical joints of the tiles in different courses coincide, or whether they are laid so as to what is technically called break-joint; the former seems to have the advantage in permitting the ledge or flange to be carried uninterruptedly along the upper and lower edges of the tile.

M. Pegnaut's tiles.

Among the examples of rectangular tiles of the fifth class, those of M. Pegnaut (department côte d'or) approach, perhaps, nearest to the tile Courtois in form. They are shown of all colours—red, black, white, brown, yellow, blue, and green, and are distinguished from most others in the building by being glazed on the upper surface. In the tiles of M. Gilardoni, of Altkirch, who is said to be the originator of this class of tile, a centre projection or corrugation is introduced, by which the tile is strengthened sufficiently to enable it to bear the weight of a workman on the roof, and at the same time to be of great lightness; 140 of these tiles cover a square, which costs from 12*s.* to 13*s.*

M. Muller's tiles.

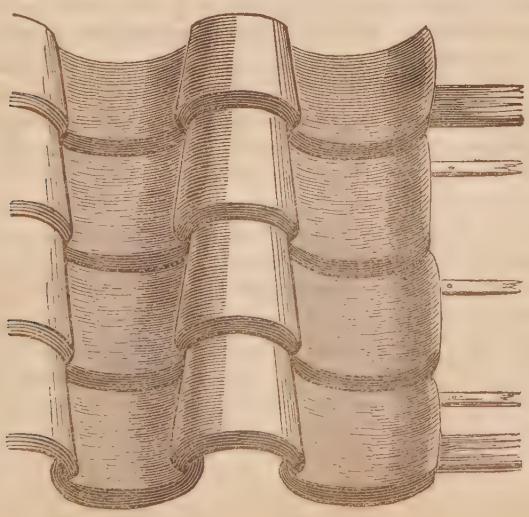
But, perhaps, the best and most complete exhibition of roofing tiles is that of Messrs. E. Muller and Co., of Paris, who provide not merely for a covering, but also give the means of introducing skylights, either to open or fixed, ventilation tiles, and of employing tiles as flashing, round chimneys, and in similar situations. The form of the tile seems a little complicated, but not at all so as to render it more difficult to be fixed, or to require a more skilled description of labour for that operation, and this slight complication does not seem to affect the manufacture in any way, their price not differing from that of the average of the tiles exhibited. This tile, which may be better understood by a reference to the cut, has the fillets or flanges along its lower edge slightly returned parallel to the face of the tile; this return being locked into a corresponding recess in the tile next below it, more effectually secures it from the action of the wind, and at the same time gives a water-tight joint without the necessity of a high pitch. The longitudinal joint is formed by two small fillets on the face of the one tile, fitting into two grooves in the reverse of the next, thus being secured by three edges lapping over two, instead of merely one over one as in the


CAST IRON SKYLIGHT FRAME TO FIT THE TILES.
CAST IRON FRAME FOR GLASS SIZE OF 2 TILES.
CAST IRON GLAZED FRAME
COMMON TILES
SKYLIGHT
2'8"
VENTILATION TILE.
ORNAMENTAL RIDGE TILE.
COMMON RIDGE TILE
FLASHING TILE
GLASS.
SECTION OF CAST-IRON GLAZED FRAME.

tile Courtois. The method of providing for the insertion of a skylight is extremely simple and ingenious; it consists in having a cast-iron frame, with edges made to correspond with those of the tiles, and of the size of one, two, three, or more tiles; this frame forming the skylight frame is fixed in any part of the roof with the same facility as the tiles themselves, and is, of course, in every respect as weather-proof at the joints. Should light without air be required, recourse is had to a still simpler cast-iron frame, with a pane of glass inserted in it; and should ventilation alone be the object, special ventilating tiles can be introduced as often as necessary while laying the ordinary tiles. In the construction of roofs with the tile of Messrs. Muller, not only is the steep slope of an ordinary tiled roof avoided, but the pitch is reduced far below that of an ordinary slate roof, being only one-eighth of the span, or at a slope of one in four. The weight of a single tile on this system is 5·5 lbs., and as it takes 150 to cover a square, it follows that this quantity of covering weighs 825 lbs., or somewhat more than with some of the lozenge-shaped tiles; but this is more than compensated for by the decrease in amount of covering consequent on the alteration of pitch, by the additional security afforded against wind and weather, and by the facility obtained in the fitting of skylights, &c., by the employment of the tiles of Messrs. E. Muller and Co., whose merit the jury of this class has acknowledged by the award of a first-class medal, and whose productions are well worthy the attention of constructors in this country.

Bridge tiles.

The only other description of tile that remains to be noticed



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is that in which the longitudinal joint is formed by a similar flange on the face of each tile placed contiguous to each other, and covered by a cap or bridge tile, either similar to the first, turned upside down, or formed like the Italian roofing in the shape of a mere fillet covering the joint. A modification of this system is exhibited by M. Courtois, which, however, does not seem to possess the same advantages as many of those kinds above described, and is, at the same time, more expensive than any of them, being 55*s.* 6*d.* the square.

M. Courtois.

Flooring tiles.

The use of tiles for flooring, although but rarely seen in England in modern constructions, prevails to a very great extent in France, and as a consequence we have the French part of the Exhibition full of many varieties of this useful material, some of the manufacturers claiming beauty of colour or design, some excellence or durability of material, and others lowness of price, as the distinguishing mark of their particular make or clay. When we speak of tile-making for purposes of flooring or pavement having almost become extinct in this country, we must not forget to speak of the revival of the manufacture of encaustic tiles, a revival which has resulted in the development of that branch of art-manufacture to an extent far surpassing the original type, and of which Mr. Minton has given such beautiful examples in connexion with his exhibition of pottery, examples that are quite unapproached by any efforts in that direction of the foreign makers in the Exhibition, and must be mentioned quite by themselves. At the same time, it should be noticed that this beautiful manufacture, from its price, is essentially "de luxe," and precluded from being so extensively employed in ordinary houses, as is the case with the less expensive and more common kinds so universally used in France for the flooring of passages and rooms, both up and down stairs, even bedrooms being constantly floored with this material, which has the advantage of being fire-proof, and when covered with a carpet, much more noiseless than a wooden floor; it seems, however, judging by the examples seen in France, to be difficult to render and keep the tiles perfectly true and level, which must thus form rather a destructive substructure for carpets. Some tiles, also with encrusted patterns, appear among the contributions of the Paris manufacturers, which seem executed with considerable nicety, and the patterns are good in themselves, but there is not that beauty of design or high finish of execution which distinguishes Mr. Minton's manufactures of this class; in one branch, indeed, that of tesseraæ for pavement, he is the only exhibitor, none of the French or other foreign potters having exhibited anything of the kind. M. Martin-Brey, of Besançon, has some good flooring tiles, and at a moderate price, viz., 6*d.* per foot superficial; they are glazed

Mr. Minton.

M. Martin-Brey's tiles.

tiles of a dark reddish brown ground with a geometric pattern in yellow encrusted in the surface. M. Vollant, of Chateau-rouge, exhibits several specimens of pavement, some in patterns formed with diamond-shaped tiles, imitating dark and light marbles, interspersed with white, red, and black, the price of which is 6*d.* per foot superficial, one a chess-board pattern in black and white at 5*d.* per foot superficial, also one at the same price in which white octagonal tiles are filled in with small square red ones, a sample at 4*d.* the foot, in which white hexagonal tiles and diamond-shaped imitative marble make up the figure, and finally a very pretty herring-bone brick pavement, in which small cubes of black brick are introduced with good effect between the ends of the other bricks, the price being 6*d.* a foot. The maker claims for these that they are unaffected by heat, frost, or water, that they wash well, that their colours are unalterable, and that being all of precisely the same degree of hardness, there is no possibility of any unevenness in wear, as is the case where materials of different kinds are employed in conjunction.

M. Vollant's tiles.

A piece of flooring is exhibited by M. Dufour to illustrate a kind of tile, if it may be so called, of his invention, which is made of a kind of white cement or plaster, with a pattern in black asphalte encrusted in the surface. They do not seem to have any advantage over tiles properly so called, as they are much dearer, ranging from 6*d.* to 1*s.* 6*d.* the superficial foot, and do not appear to promise the same amount of resistance to wear and tear.

There is another invention, exhibited in the "Annexe," which being used as a tile in the construction of pavements, may perhaps be introduced here, although not belonging, strictly speaking, to this kind of manufacture; it is a flooring material made of hexagonal cast-iron frames, which have parts of their surface sunk so as to form a series of cells; these are filled up level with asphalte or cement of different colours, which is prevented from being worn down by the sides of the hexagons and the other projecting parts of iron, these latter at the same time being so arranged as to form an ornamental pattern or design. The principle is somewhat similar to that of the cast-iron street pavement lately laid down in Leadenhall-street; the price is not stated, but would probably be considerably more than that of tiles, and it is doubtful whether the increase of durability would be sufficient to compensate for a larger outlay.

Perhaps the best specimens of flooring tiles in the Exhibition are those shown by M. Chabert, of St. Just des Marais,

M. Chabert's tiles.

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a very smooth, even, unglazed, octagonal tile of a beautiful cream-colour, and so close in texture as almost to take a kind of polish. They are accompanied by small square red tiles for filling in between the octagons. The price of the octagons per 10 feet superficial is 4*s.* 6*d.*, and the necessary number of red squares for this dimension is 1*s.* 3*d.*, so that the pavement complete costs rather less than 7*d.* per foot superficial.

M. Carpentier's tiles.

M. Carpentier (Seine Inferieur), shows red and cream-coloured flooring tiles, some with only one colour on each tile, others with red pattern on a white ground, and *vice versâ*, the price being from 6*d.* to 1*s.* per square foot. From Ponchon (Oise), there are some tiles in the style of Dutch tiles, blue and white, and blue, white, and yellow, in squares, and a M. Fossarien (Paris) exhibits flooring tiles of a material which he calls "Carrelage ceramique anhydroplastic," which are painted in various colours, and are said by the maker to be durable; but these again being made of a material that sets hard in a few hours without being submitted to the action of fire, come rather under the head of cements than of pottery, as the name would seem to imply. There are some very well finished and good coloured tiles from Chartres, they are whole coloured red and white unglazed, of three forms, octagonal, hexagonal, and rectangular, and the prices and dimensions are as follows:—

Tiles from Chartres.

Octagonal (pure white), 9 inches in diameter, 4*l.* 16*s.* per thousand.

Octagonal (red), 9 inches in diameter, 4*l.* 8*s.* per thousand.

Rectangular (white), 9 inches by 4 inches, 2*l.* per thousand.

Hexagonal (red), 8 inches diameter, 2*l.* 5*s.* per thousand.

Tiles from Turin.

Some curious looking flooring tiles are exhibited by Messrs. Corballa-Delucca and Co., of Turin; they are thin, light, well burnt and made, but being meant to represent a dull reddish coarsely veined marble, they are not so pleasing in appearance as some of the French flooring tiles enumerated above; with this single exception none of the foreign states contribute anything under this head.

Bricks.

Bricks, both of ordinary make and hollow, are also almost entirely confined to those of French manufacture. As exceptions to this may be mentioned Messrs. Cartwright, Burton-on-Trent, and Ramsay, of Newcastle on Tyne, who exhibit fire bricks and lumps; there are also two beautiful samples of white brick from Toronto in Canada, five or six ordinary looking bricks from Van Diemen's Land, which were bought by a French maker, M. Boric, for, I think, five francs; and a sample of brick from the Penitentiary at Kingston, Jamaica.

French.

The principal show of French bricks was from the Burgundy district, and their distinguishing feature is their very beautiful colour. They are a rather small brick, very even, and of a very remarkable tint of reddish brown, which forms a good contrast with dressings of any warm light-coloured stone, such as Caen stone or the building stone of the Paris basin. A M. Gerard has some small red bricks roughly glazed on one side, apparently a rude imitation of some hollow bricks with coloured glazes, which were exhibited in 1851. M. Mallé, of Paris, shows some bricks with a very deep projection on one side keying into a corresponding hollow in the next brick. Messrs. Chaudet and Son, of Paris, have some hollow bricks of a peculiar form for making partitions, ceilings, flues, &c.; they are about 9 inches by 7 inches, and $1\frac{1}{2}$ inches in thickness, each brick having a projection at one end which fits into a groove in the end of the next. They are used on edge, and some of them that are shown put together seem to form an extremely strong and good partition. Their weight is from 3 to $3\frac{1}{2}$ lbs. each; they are furrowed on the outside for plaster where it may be required, but the bricks themselves being of a good greyish white colour, this might, perhaps, be omitted in many cases. Partitions formed in this way have the advantage of being proof against fire, vermin, and sound, and of saving room by being not more than half the thickness of an ordinary lath and plaster partition.

Partition bricks.

M. Borie's hollow bricks.

M. Paul Borie, of Paris, has a very large and valuable exhibition of his various kinds of hollow brick, which are now so largely employed in all constructions in Paris. They are made of six different dimensions, to suit the various uses to which they may be put; viz.—

No.	Length.	Breadth.	Thickness.	Weight of each.	Price per 1,000 delivered in Paris.
1	$8\frac{3}{4}$ inches	6 inches	$1\frac{1}{2}$ inches	2·8 lbs.	48*s.*
2	$8\frac{3}{4}$ „	$4\frac{3}{8}$ „	2 „	2·9 „	48*s.*
3	$8\frac{3}{4}$ „	$4\frac{3}{8}$ „	$2\frac{3}{4}$ „	2·9 „	48*s.*
4	$8\frac{3}{4}$ „	$4\frac{3}{8}$ „	$4\frac{3}{8}$ „	5·4 „	80*s.*
5	$8\frac{3}{4}$ „	$4\frac{3}{8}$ „	$4\frac{3}{8}$ „	5·4 „	80*s.*
6	$8\frac{3}{4}$ „	$5\frac{1}{2}$ „	$3\frac{1}{4}$ „	5·4 „	80*s.*

These bricks differ from the hollow bricks that are in use in England in the form and extent of their perforations or hollows. Those that have appeared in this country being generally pierced with a number of small round holes in a transverse direction, and M. Borie, on the other hand, constructing his with one or more rows of square openings

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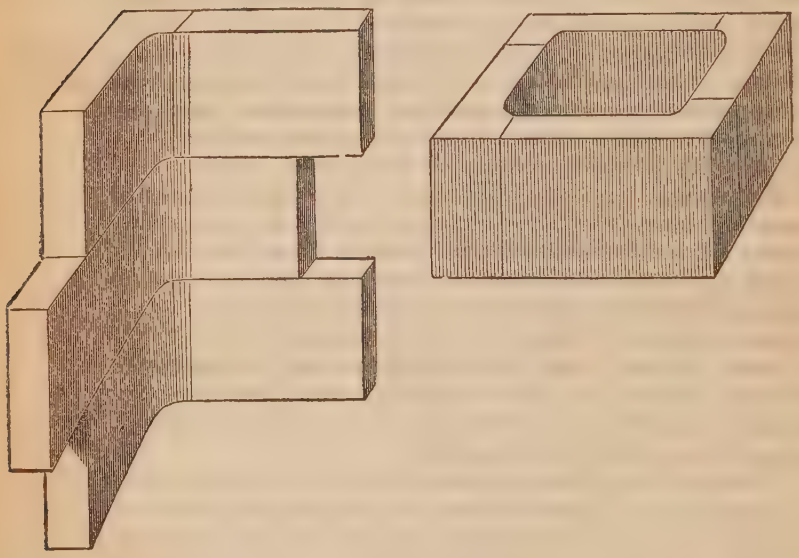
running from end to end of the brick, and so disposed that every part of the skeleton, as it might be called, into which the brick is thus divided, is precisely of the same thickness, and that, consequently, there is no tendency to shrink in one part more than another, and that all parts are equally burnt, and the brick of equal strength throughout. They are made of a very fine clay, and are said to be stronger than solid bricks. These hollow bricks are used not only for brick-work in walls, but also on edge in partitions similarly to those of M. Chaudat, and the principle is also carried into the manufacture of lintels for doors and windows, which are made of the required lengths by M. Borie, of brick clay, and perforated with longitudinal openings, the same as in his bricks. A hollow brick beam of the same section as one of his smallest common hollow bricks—viz., $4\frac{3}{8}$ inches wide, and 2 inches deep, pierced with two longitudinal openings, which reduced its sectional area to 4·2 square inches, was loaded during the whole time of the Exhibition with a weight of 220 lbs. on its centre, the extremities being supported on bearings, 3 feet 9 inches apart, and another of these long bricks or lintels, measuring $4\frac{3}{8}$ wide by $2\frac{3}{4}$ deep, with a solid sectional area of not more than 5·2 square inches, bore with the same bearings, viz., 3 ft. 9 in. between the supports, a weight of 440 lbs. on its centre.



M. Hasbrocq's bricks.

M. Hasbrocq, architect of Paris, shows bricks moulded into peculiar forms for special purposes, as, for instance, for the construction of flues, for which he employs a brick, the form

of which may be better understood by reference to the annexed cut. He also proposed the same shaped brick to be used for rounding off the angles of rooms, and when covered with a white porcelain-like glaze to be employed in conjunction with a similarly glazed flat brick, for linings of apartments where glaze is preferable to plaster, as, for instance, water-closets, &c. In the first figure these bricks are represented as forming a flue, and in the second, they are shown lining the corner of an apartment.

Count de Pourtales' bricks.

In passing from the subject of hollow bricks to that of terra-cotta employed in construction, we first come to the exhibition of the Count de Pourtales, whose goods fill a sort of intermediate position between tiles and bricks, they are a species of terra-cotta tile or slab, strengthened on the lower side by deep ribs or flanges running longitudinally from end to end, and are proposed to be employed in forming ceilings, more especially where plaster cannot be conveniently used, in stables, &c.; the specimens shown are about 18 inches long, by 6 or 7 inches in width, with a thickness of from half to three-quarters of an inch, and having four ribs each 2 inches deep and half an inch thick. They are shown bridging from one joint to the next, their ends resting on a small fillet attached to the lower part of each joist. They have the advantage of combining great strength and lightness, and in connexion with iron joints, would no doubt make an admirable fire-proof ceiling, and the system might probably be extended to the construction of floors also.

Mr. Taylor's terra-cotta facing.

An Englishman, a Mr. Taylor, has a method, a very ingenious one, of facing brick buildings with a thin veneer (as it may be called) of terra-cotta; the pieces of terra-cotta which he uses are flat tile-shaped slabs of about 15 inches by 9 inches, and 1 inch thick, with a small return or fillet extending along the upper edge, which forms the means of connecting it to the brickwork; he proposes to employ the same system with any building stone that is sufficiently manageable to be readily sawn into similarly shaped slabs, and exhibits a model showing a very neat way in which a great number of these pieces may be sawn out of a block of stone without waste, so that a house may be faced with less than a sixth part of the stone at present employed for the same purpose; this system is said to have been tried in several houses with perfect success.

Terra-cotta: French.

There are two French manufacturers who exhibit very fine specimens of terra-cottas, as applied to architectural decoration; viz., M. Virebent, of Toulouse, and M. Garnaud, of Paris, the former of whom has a magnificent deeply recessed and elaborately sculptured Norman doorway, the recessed sides of which decorated with figures of saints in

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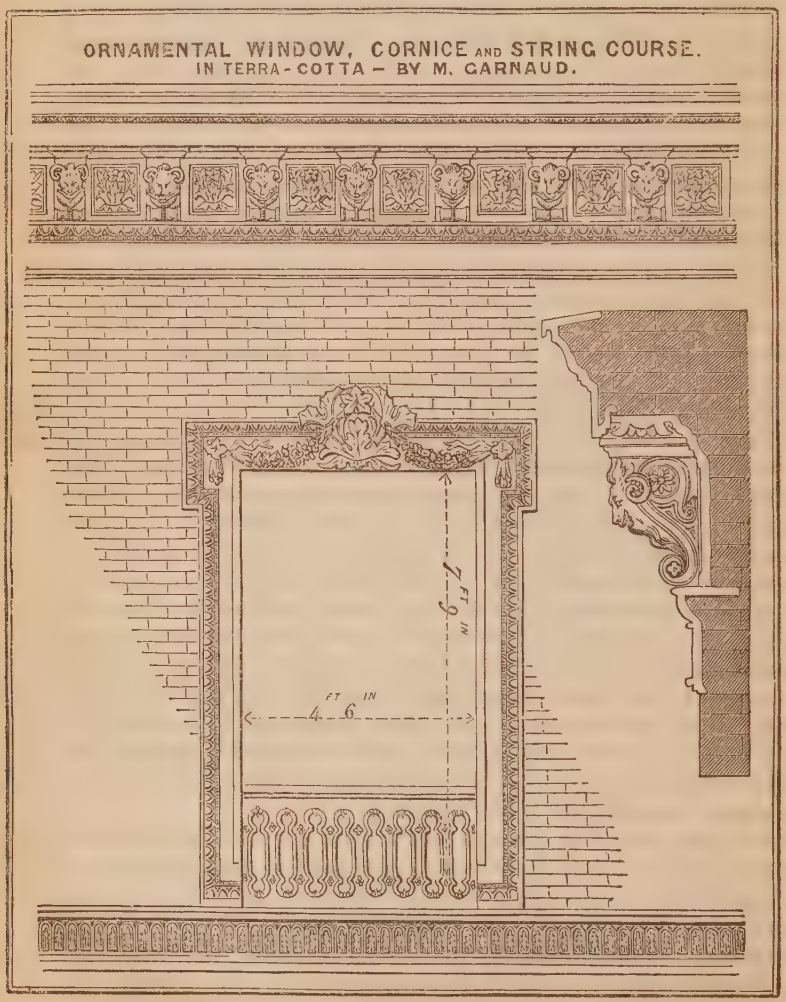
niches, and the arch mouldings in many highly-ornamented concentric rings, would have been very costly to produce in even the softest and most easily-wrought stone, as it presents a surface of from 250 to 300 superficial feet of carving. It is here produced in a beautiful Caen-stone-tinted material for 120*l.*, or not 10*s.* a foot superficial.

M. Garnaud's terra-cotta window.

M. Garnaud exhibits a window dressing for a window 7 feet 9 inches by 4 feet 6 inches, with an egg and dart moulding all round, wreaths of flowers and leaves over the window, a balustrade across the lower part, and an ornamental string course underneath; the whole surmounted by



a very handsome cornice, supported on consoles in the form of grotesque heads. It is made of good coloured material, without casting or warping, and was bought for the sum of 12*l.*, an amount which any one must be aware would go a very small way in producing the same subject in stone. This material has been used with success in France for external decorations, and would seem to offer peculiar advantages for the same purpose in this country, more especially in localities such as London, where stone dressings are so expensive that their use is almost abandoned in ordinary cases, and recourse is had to cements and compos of various kinds, which are far inferior, both in effect and in lasting qualities, to the terra-cotta. The window in question was shown in a portion of a wall constructed of the rich reddish-brown brick of Burgundy, and the effect and contrast of colour were very striking and good.

A chimney-piece in biscuit, by M. Gille, and some caryatides and other figures in the same delicate material, intended for interior decoration, do not give so successful a result as the coarser terra-cotta, as they cannot compete with marble in appearance, and probably will exceed it in price; and the difficulty of executing such large subjects in such a material, a difficulty which is well exemplified by the cracks and failures of which those exhibited are full, will always present a bar to its being extensively employed in construction.

Porcelain decoration.

In the garden behind the Palais de l'Industrie the front of a house is shown, which is largely decorated with plaques of earthenware or porcelain, painted with flowers and other devices in colour. The effect is more fantastic than in accordance with good taste, but still the attempt is not without value as suggestive of an exterior decoration, which might be turned to good account in an atmosphere like that of London, where its quality of readily washing and being easily and cheaply cleaned would render it worthy the attention of shopkeepers, as being in this respect more economical and better looking than paint.

Perhaps the most successful application of earthenware to decoration is exhibited in the construction of the Exhibition building itself, where, in the grand entrance, in a kind of open porch, may be seen some two or three circular plaques or medallions of Lucca della Robbia ware, which are inserted in the ashlar work of the wall with extremely good effect. Altogether there is enough to convince any one who may look into the subject that terra-cotta and earthenware may be brought with advantage to play an important part, both in the construction and decoration of our edifices of all classes and for all purposes.

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Asphaltes.

Again referring to the French classification of objects in the Exhibition, we come to the next subject, which is that of asphaltes and bitumens, both natural and artificial; and here, as in the last section, we find the great bulk of the articles exhibited are from France, which country, indeed, supplies almost all the material of this kind at present in use; in fact, with the exception of one exhibitor from Switzerland, M. Babineau, and specimens of asphalte from a Canadian Company at Hamilton, all the asphalte exhibited was French.

The floors of several parts of the Exhibition building presented good examples of the various methods adopted in Paris for laying asphalte as a pavement, whether plain, ornamented with patterns in various colours, or marked into small squares by deep scores, to form a footing for horses; this substance is now very much employed in Paris in the construction of footpaths to the different streets and open places, and seems to have met with much more success for this purpose than in England. Nothing novel, either in form or manner of treatment of asphalte as a pavement, has been elicited, but a material exhibited by Messrs. Automeyer, of Paris, is deserving of notice, it is called "bitume laminé," and is proposed for roofing flats, and in fact for all roofing purposes for which lead or zinc is now employed, such as the covering of domes or cupolas, flashings, gutters, &c., and, with the exception of its non-capability to resist the action of fire, seems well adapted for that kind of work. A small summer-house was shown covered with it, and was made in the most irregular forms, apparently with a view of showing the facility with which the material could be employed, and although it was exposed through the whole summer to the intense heat of a Paris sun, it never at any time showed any symptoms of becoming soft, nor did it even in the parts where it covered the perpendicular sides of the small erection, exhibit at the close of the summer, any traces of having run, or altered in form, or in any other respect; it is a preparation of asphalte in the form of sheets, which can be procured of several thicknesses and widths and of any length, (that exhibited being about a yard wide and three-sixteenths of an inch thick,) and is applied somewhat like sheet lead, the joints being made by slightly melting or softening the parts to be joined by a hot iron. It might, perhaps, be employed with advantage as a substitute for lead in lining water-tanks or cisterns, and in fact in any situation where lightness and cheapness was an object; in the two qualities of lightness and facility of application it has a decided advantage over the former material.

Bitume laminé.

The next subjects in the classification are "metal and wood (except when referred to Classes I. and II.)," treated specially with regard to their qualities as materials of construction.

The Exhibition, as would naturally be expected, presents great variety, and contains many points of interest in connexion with the employment of iron in construction; and this part of the subject is above all others characterized by the display of novelties and improvements in the application of this most important material; and there seems to be one singular difference between the two countries in the direction which the employment of iron seems to be taking; for while in England it has become the property of the civil engineer, and is almost entirely confined to large and important constructions, in France, on the contrary, wood and stone still seem to be the most popular materials for this class of works, and iron, although employed also to a considerable extent in civil engineering, has entered on a course in which it is comparatively unknown in this country, namely, that of supplying the place of wood in private and domestic edifices. The iron made use of for this purpose also shows a difference between the practice of the two countries, England making use of cast and wrought iron, while in France the iron now invariably used for all girders and beams in the construction of houses, is rolled at once into the exact form required.

Iron in construction.

The employment of rolled iron in girders and joists for floors, which is almost unknown in England, and which is now very largely adopted in Paris, owes its origin to the circumstance of a very extensively organized strike of carpenters which took place in that city in the year 1846, before which time iron was, even to a greater extent than in this country, debarred by its price from entering into competition with wood in the construction of buildings and private dwellings. In order to extricate themselves from the position in which they were thus placed by such an event, and with a view of preventing its recurrence for the future, the Parisian architects and builders turned their attention to the substitution of iron for wood, both in the roofs and also in the flooring of buildings, and more particularly to the best means of reducing the weight and cost of the material, which, as stated above, formed the greatest obstacle to its general employment. The first difficulty to be encountered was to obtain a sufficient supply of iron of the sections most suitable for the purpose, the roofing of several of the theatres, which had been constructed by a combination of such sections as could be obtained in the market riveted together, showing that the cost of labour consequent on such an arrangement must necessarily prevent its being generally employed.

Rolled iron girders.

M. Vaux proposed and carried out the application of very thin flat bar or plate iron for floor joists, but these being

M. Vaux's girder.

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obviously ill-adapted to give the necessary amount of lateral stiffness and rigidity, were quickly superseded by a joist or girder whose section was in the form of a cross, proposed and made by M. Bleuze, and in which he sought to give lateral rigidity by a single flange at the neutral axis of the beam, which thus assumed in section the form of a Greek cross. This, although a failure as far as the section was concerned, was a great advance in one respect, viz., that it was an iron beam made in one piece, specially for the purpose for which it was intended, instead of being merely made up of various shapes riveted together, as had been formerly the case, and as is to this day the case in constructing wrought iron girders in England. Much of the difficulty experienced by the French architects in perfecting this new construction was occasioned by the fact that, according to the custom which obtained at the time, the iron was transmitted from the manufacturer to the builder through the intervention of a dealer, who was totally ignorant and careless, both of the requirements of the latter or of the capabilities of the former to meet those requirements, and it was not until the manufacturer and builder were brought directly into communication that the best forms of iron were made, especially for the purposes of construction, forming what are called in France "fers speciaux."

M. Bleuze's girder.

The cross-shaped girder of M. Bleuze being, as might have been expected, weak in proportion to its weight, recourse was had to a girder which was first adopted in the construction of the St. Germain railway station, and which was a slight modification of the common **I** rail, but which being made a great deal too heavy, fell to the ground from its consequent high price, and it was not till the month of February 1849, that the **I** girder as now used was produced, and first applied in Paris in the flooring of a house, No. 18 in the Boulevard des Filles du Calvaire for a bearing of 18 feet. A number of experiments were instituted by M. Zorés, for the purpose of obtaining the best possible section for these new rolled iron girders, which resulted, first, in proving the uselessness of a third flange which had been introduced by some makers, as in the case of M. Bleuze's girder, at the centre or neutral axis of the **I** girder, and afterwards in the gradual development of what are now considered in Paris to be the best and most practical forms of rolled iron girder, and which are described below.

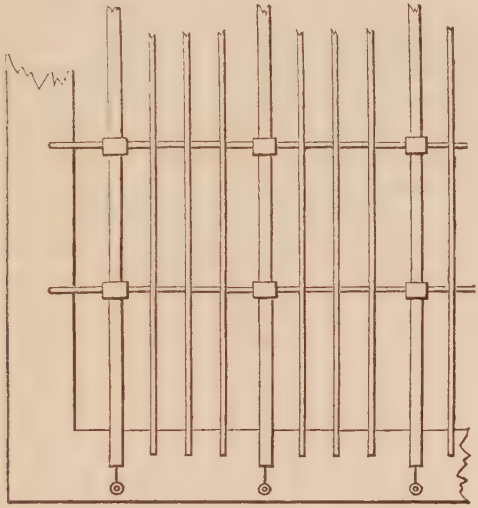
M. Zorés' system.

The principle of the substitution of rolled iron for wood having now been established, numerous modifications were proposed in the manner of its application and arrangement,

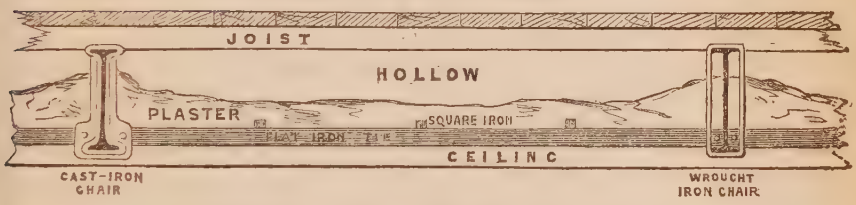
as to the ties, struts, and connection with the remaining parts of the floor and ceiling, for both which a variety of methods of construction have been from time to time adopted, and of which some of what are considered the best forms are here described.

METHOD No. 1.

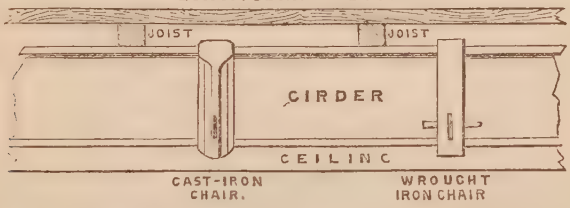
PLAN.



SECTION ACROSS THE GIRDERS.



LONGITUDINAL SECTION



The first has the girders of I shape, slightly arched, having a rise of ·06 inches in each foot, placed at a distance of 3 feet 3 inches from centre to centre, and connected at intervals of 3 feet 3 inches throughout their length by ties of flat bar iron on edge, resting on the lower flange of the

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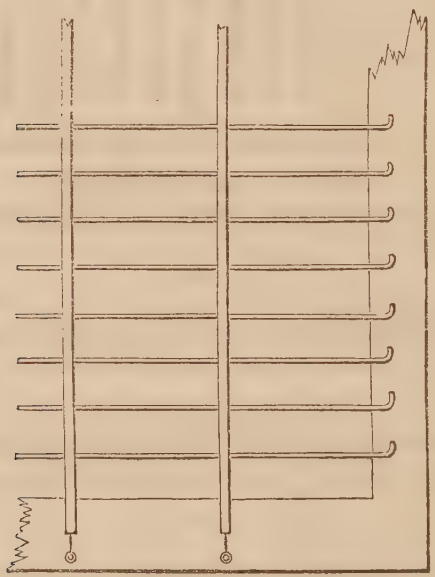
girder, and fastened one to another either by wrought-iron straps or cast-iron chairs. Upon these ties are placed square bars, three between each pair of girders, running parallel to them from wall to wall, into which their ends, turned down, are built. The girders are further tied to the walls at each end by iron straps fastened to vertical iron bolts in the wall, and in a lateral direction by the ends of the cross ties being also built in in the same way as the longitudinal bars. On the iron framework so formed the thick plaster ceiling is formed without wooden lathes, a wooden platform being held under it while the plaster is thrown in from above, and removed after it has firmly set. Small square wooden joists are laid over the girders, and the wooden floor laid on these in the ordinary way.

In the second method described, the **I** girders are also placed at from 3 feet to 3 feet 3 inches from centre to centre, and are tied, or rather shutted, at intervals of one foot by small square bars, reaching from girder to girder, and resting on the

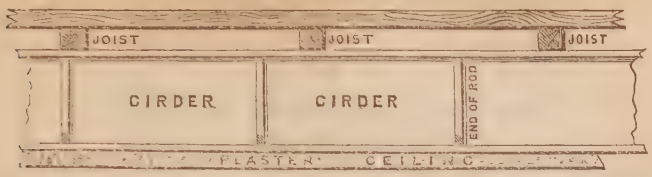
METHOD No. 2.

PLAN.



SECTION ACROSS GIRDERS.

SECTION ALONG CIRDERS

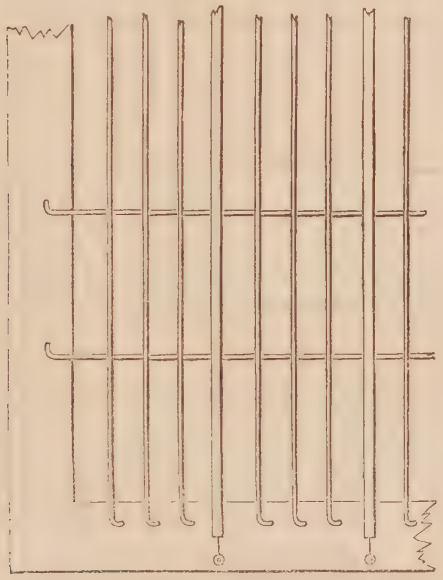


lower flange, having their ends turned up in an elbow the height of the web of the girder, and kept upright merely by the plaster with which they are filled in; this, as will be seen at once, is the most simple of these methods, but it is deficient in the ties with which the others are strengthened.

The third method differs from the first merely in the manner in which the cross-ties are connected together, being a simplification of the chair already described.

METHOD No. 3.

PLAN.



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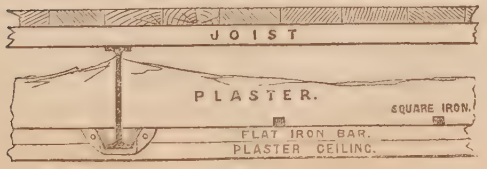
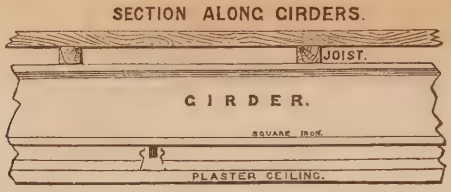
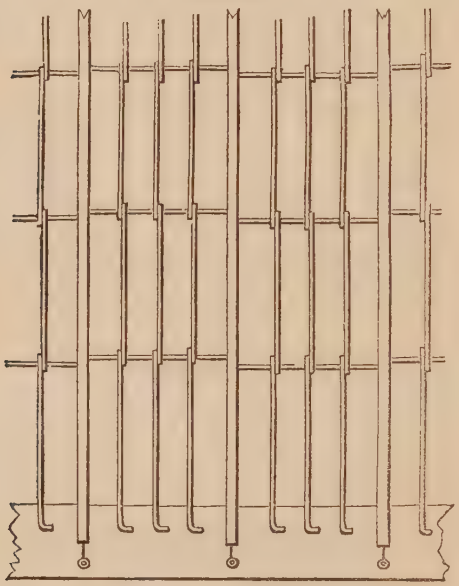




The fourth method is that which has generally had the preference among the principal builders; in it the girders are tied together in pairs, at 3 feet intervals, by round iron bolts $\frac{6}{10}$ ths of an inch in diameter, passing through holes at the neutral axis of the girder, and nutted up at each end. Small square bars are hung on to these tie-bolts by hooks at their extremities, of sufficient length to permit them to hang nearly level with the bottom of the girders, to which

METHOD No. 4.

PLAN.



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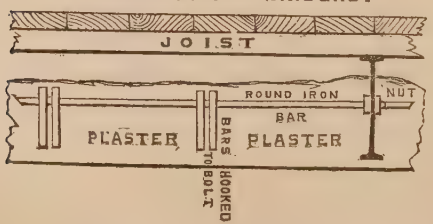
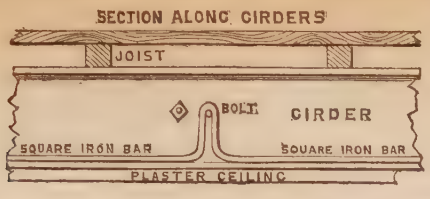


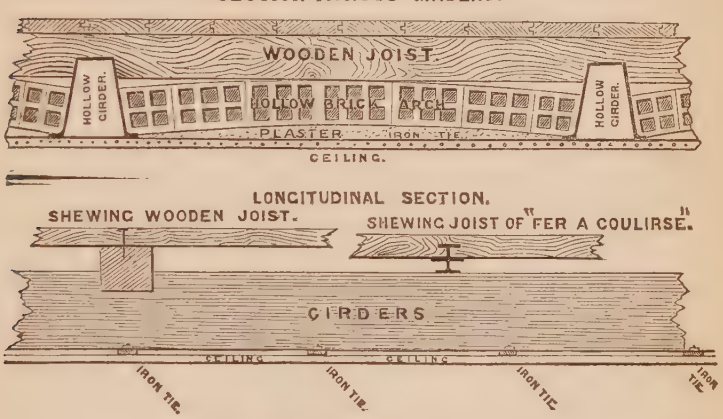


they are parallel, as described in the first method, the description of the floor and ceiling of which answer for all four methods.

In speaking of the gradual development and improvement in form of the rolled iron girder, an allusion was made to forms now in use in Paris which are considered superior to the **I** section commonly employed, of which the four methods above are applications. These were exhibited by M. Zorés along with the collection of hollow bricks by M. Borie, and were of two forms, called by the inventor "fer tubulaire" and "fer à coulisse," the first being, perhaps, more strictly speaking a girder, and the latter a joist, where only a single floor is required.

Fer tubulaire

The "fer tubulaire" may be described as being in section of the form of a capital **A** without the small triangular top; those exhibited are said to be for a bearing of 20 feet and are of the following dimensions, viz., $4\frac{3}{4}$ inches high, $2\frac{3}{8}$ inches



wide at top, 4 inches wide at bottom, exclusive of a small flange of $\frac{3}{4}$ inch projection on each side. The sides of the girder are $\frac{2}{10}$ ths of an inch in thickness, and the top and flanges $\frac{7}{20}$ ths. These girders are placed at a distance apart of 2 feet 8 inches from centre to centre, and are tied together at intervals of 3 feet by flat bar iron ties of $\frac{3}{4}$ inch × $\frac{3}{10}$ inch

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bolted to the bottom of the flanges, and the flooring finished according to one of the following methods.

Method No. 1.—Flat arches of hollow brick between the girders with joists of "fer à coulisse," (hereafter described,) or of wood, and wooden flooring, or for passages with the spandrills filled in with plaster and floored over with tiles, ceiled underneath to soffit of flat arch.

Method No. 2.—The spaces between the girders filled in with hollow blocks of plaster 4 inches deep. Flooring and ceiling as in No. 1.

Method No. 3.—Wooden flooring as in No. 1, with ceiling on small iron lathes; hollow between floor and ceiling.

Method No. 4.—Wooden flooring without ceiling.

The girders of this section are said to possess the following advantages over those of the **I** form commonly used; first, with equal weights they give a strength or resistance nearly double, as ascertained by the following experiment: a girder of this form, 20 feet in length, $4\frac{3}{4}$ inches in depth, and weighing 9·5 pounds the foot, deflected 2·34 inches with a load on its centre of 3 tons.

A girder of the **I** form, 20 feet long, $8\frac{1}{2}$ inches in depth, weighing 16·9 pounds the foot, deflected 2.49 inches with the same weight.

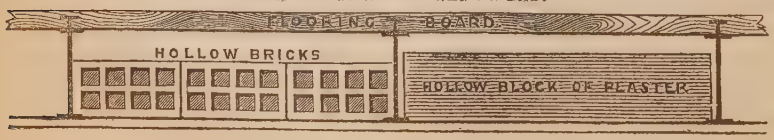
Again, on the score of economy. A floor of 20 feet square, calculated to bear a weight of 200 lbs. on the square foot, exclusive of the weight of flooring, costs in Paris 9*l.* 6*s.* 10*d.* per square, including everything, when executed with the **I** rolled iron girder; and a floor similar in all respects, but having the girder "fer tubulaire" substituted for the **I**, costs but 7*l.* 9*s.* 5*d.* per square.

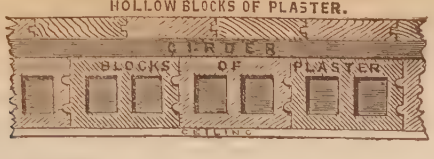
Another great advantage that this form of joist has over that in ordinary use in Paris is, that it does not require any strutting, while the **I** girder requires lateral pressure to such an extent that it is said not to be employed to the best advantage unless absolutely filled in with either hollow brick arches or plaster, more than half of its strength being dependent on its lateral rigidity.

Fer à coulisse.

The other form of girder or rather joist, viz., the "fer à coulisse" exhibited by M. Zorés is said to be the invention of a M. Chibou. It is of the form of the **I** or double **T**

SECTION ACROSS THE GIRDERS.





girder, but with the addition of a second upper flange, longer than the first and close to it. The dimensions of the specimens exhibited are girders $5\frac{1}{2}$ inches deep, top and bottom flanges 1 inch wide, third flange $\frac{4}{8}$ths of an inch below the top one, and $1\frac{4}{8}$ inch wide, and the thickness of the web and all three flanges alike, viz. $\frac{3}{16}$ of an inch. A girder of this section weighs 3·6 pounds the foot.

These girders are placed closer together than those just described, viz., at a distance of 1 foot 8 inches from centre to centre; and are said to possess considerable advantages as compared with those of the **I** or double **T** form; first, as to strength, the addition of the second upper flange, from its position so close to the first, may be said to form, in conjunction with it, one flange, having nearly the same resistance to the compressive force exerted above the neutral axis as if it were a single top flange, and coming very near to that which has been laid down by Mr. W. Fairbairn as the best proportion between the top and bottom flanges of malleable iron girders; while, at the same time, it exerts a considerable influence in stiffening the girders in a lateral direction, and thus materially tends to remedy the defect spoken of above, of being liable to torsion or twisting under heavy strains, unless well strutted or filled in solid with brick, plaster, or other material. A second advantage claimed for this section of girder is, that it affords a means of laying flooring at once on the iron without the intervention of joists, and without the employment of nails; and this is effected in a very neat way by having each end of the oak batten, of which the parquet or French flooring is formed, ploughed with a tolerably deep groove

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into which the top flange of the girder fits, the lower side of the batten resting on the second or broad flange, and its upper surfaces meeting over the centre of the top flange, which is thus effectually hidden; and this method is not only more economical in the first instance, but has the additional advantage of rendering it impossible for any board of the floor to get out of level or start up, and also to give the means of removing the whole or any part of the floor at any time, and relaying it without the slightest injury, and also of tightening it up in case of any shrinkage of the wood. The facilities for laying a floor in this way are much increased by the French method of flooring with oak in short lengths, and in a kind of herring-bone pattern called "point de Hongrie." As to the expense, the following is the cost of a square of flooring in Paris, executed in three different ways, viz., in wood, in double **I** iron, and in the "fer à coulisse" just described.

Composition estimates.

First, in wood:—

	£	s.	d.
Fir, rough and framed, in girders -	2	10	0
Ceiling, and ceiling joists - - -	1	5	0
Sound-boarding and pugging - -	0	12	6
Flooring, including joists and nails -	3	10	10
Fixing joists - - - - - -	0	4	2
Ironwork - - - - - -	0	10	0
Total for a square -	£8	12	6

Secondly, in double **I** Iron:—

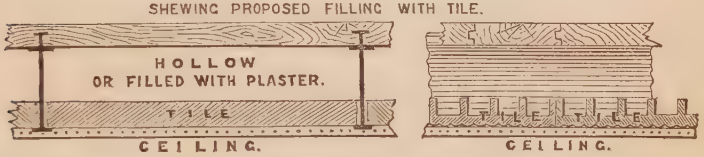
	lbs.
Rolled iron, in **I** girders 2 feet 1 inch apart, 49½ feet, weighing 6 pounds per foot run	297
Rolled iron, in struts and ties - - -	77
	374

	£	s.	d.
At 22*l.* per ton, including fixing - -	3	13	6
Ceiling, without ceiling joists - -	0	16	0
Filling up solid with plaster - -	1	12	6
Fixing joists - - - - -	0	4	2
Flooring, including joists and nails -	3	10	10
Total for a square -	£9	17	0

Thirdly, with girders "à fer à coulisse":—

	£	s.	d.
Rolled iron, in girders 1 foot 8 inches apart, 65½ feet, weighing 3·3 pounds, per foot run, 216 pounds, at 22*l.* per ton, including fixing - - -	2	2	5
Flooring, laid without nails or joists -	2	6	8
Filling in with cast hollow blocks of plaster 3 inches in depth, including plastering thereon for ceiling - -	1	4	0
Wrought iron ties, at 6 feet apart -	0	4	2
Total for one square -	£5	17	3

The ordinary price of first class rolled iron in Paris is 12*l.* per ton, which price was taken as the basis in putting the price of the girders fixed at 22*l.* per ton. In England the rolled iron could probably be produced at from 8*l.* to 10*l.* the ton, and if so, a floor of this description, perfectly fireproof, could be constructed at a cost considerably under that of the ordinary wooden floors. The weight, and perhaps the cost, of such floors might be much diminished by the employment of ribbed tiles, such as those already described as exhibited by the Count de Pourtalis, instead of



hollow brick or plaster of Paris, for filling in and supporting the ceiling; these would be much lighter, would afford a good hold for the plastering, and would give also a fireproof floor. The weight of such tiling would not exceed, perhaps, 800 pounds a square, much less than that of ceiling joists, laths, sound-boarding, and pugging, the place of which it would supply. M. Zorés has a smaller section of "fer à coulisse" which he employs for joists, and in which the web is reduced to 1½ inch in depth, the third flange being exactly midway between the top and bottom, and the dimensions of all three flanges being the same as in the girders, viz., 1 inch, 1⅝ inch, and 1 inch; these he uses with the "fer tubulaire" girders instead of the wooden joists mentioned above; and in this case the flooring is also laid without nails, in the manner described for the girders "à fer à cou-

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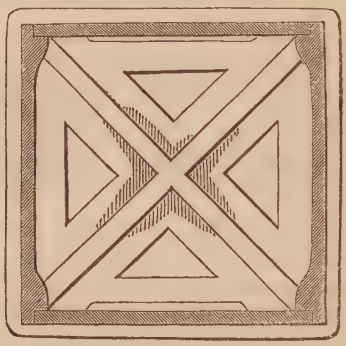
lisse." An additional advantage possessed by the girders and joists of these sections is, that a strong floor is obtained with a very much less sacrifice of space, as the following statement of the relative thicknesses of the floors will show.

For the same bearings, and to fulfil similar conditions as to strength, the thickness of the floors would be represented by the following numbers:—constructed entirely of wood, 14 inches; with double **I** iron girders, 9 inches; with the "fer tubulaire," joisted with "fer à coulisse," 7 inches; and with the "fer à coulisse," having the flooring laid directly on the girders, the thickness does not exceed 6 inches, which, in a room of 20 by 20, would make a saving in the walls of about 68 feet of reduced brickwork, equal to an expense of 3*l.*, taking brickwork at 12*l.* per rod.

Rolled iron is also shown in the Exhibition in the form of a string for a well staircase, the particular application being a patent, the property of a M. Coulon of Paris, and in fact this material seems to be to a very great extent taking the place of cast iron in objects appertaining to construction in that city. Skylights of rolled or wrought iron, some by M. Cordebart, of Angoulême, measuring 3 feet by 2 feet, are offered at from 16*s.* to 20*s.* each.

SECTION OF SINGLE GIRDER.

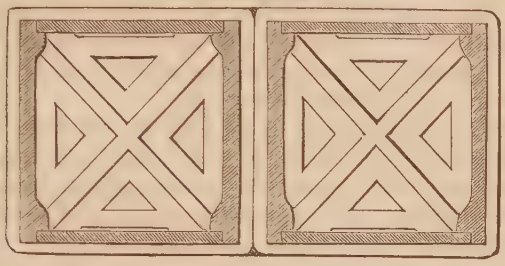


French girders from Creuzot.

A girder or bressummer is exhibited in the contribution from the manufactory of Creuzot, which consists of two flat bars or plates of rolled iron $9\frac{3}{4}$ inches deep by $\frac{5}{8}$ inch thick, placed parallel to each other on their edges, and kept at a distance of 12 inches apart by flat plates $\frac{1}{2}$ inch thick, fitting into rabbets in the first-named pieces at top and bottom. These four sides are further sustained in a rectangular form by the insertion at intervals of about a foot of cast iron frames, in the form of a rectangle with its diagonals, and at each of these frames the girder is hooped

round with a wrought iron band 3 inches wide and $\frac{1}{2}$ inch thick. The whole thus forms a very strong wrought iron box girder, without the use of a single rivet. Another

SECTION OF DOUBLE GIRDER, OR BRESSUMMER.



girder is also shown similar in construction, but double, being formed of two separate ones, such as that just described, but only 8 inches wide instead of 12 inches; the two are hooped together with wrought iron bands, that forming a bressummer of about 18 inches in width from out to out.

M. Grebel's system of girder.

Another description of girder is that exhibited by M. Grebel, of Valenciennes, who sends two specimens, one of 20 feet span, consisting of an arc of rolled iron of the I form, $4\frac{1}{2}$ inches deep and $\frac{1}{4}$ inch thick, having a height or versed sine of 2 feet to the bottom of the chord connecting its extremities, which is of cast iron 8 inches deep by $\frac{3}{4}$ inch thick, and with a bottom flange 3 inches wide; this is attached to the arc at every 18 inches of its length by a wrought iron strap 1 inch by $\frac{1}{2}$ inch. The weight of the girder is 1,122 lbs., and it is stated to be capable of resisting a weight of 40 tons uniformly distributed. The cost is 10*l.* 12*s.* 6*d.*

A lighter girder is shown by the same firm, with a portion of a floor constructed on it, it has a span of 24 feet, and is 18 inches from floor to the ceiling below; it is formed of an arc of rolled iron † shaped in section, $2\frac{1}{2}$ inches deep and $\frac{3}{16}$ thick, with a chord of rolled flat bar 2 inches deep by $\frac{1}{4}$ inch thick; a bar of T-iron, 2 inches deep by $\frac{3}{16}$ inch thick, runs tangent to the arc and parallel to the chord, and all three are connected at intervals of 2 feet by small iron straps, as in the former case. These girders are placed 2 feet 6 inches apart, and have wooden joists 3 inches by $2\frac{1}{2}$ inches notched down $\frac{1}{2}$ inch on to the T-iron tangent. The ends of the arcs are held in cast iron shoes, which bear 8 inches by 8 inches in the walls. The girders are further tied together transversely at bottom by light iron straps. The weight of each girder is 475 lbs., and its price is 6*l.*

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A model of a roof, 115 feet span, is exhibited by a M. Joly, of Argenteuil, the principals, which are 24 feet apart, are light wrought iron lattice girders, connected by angle iron to flat plates, forming flanges at top and bottom.

Rolled iron of a variety of sections is exhibited by several of the great ironworks of France, among which may be mentioned those of Creusot, Maubeuge, Montataire, La Providence ; the two latter of which show rolled girders up to a foot in height and 36 feet in length

Cast-iron.

Cast iron is exhibited a good deal in the form of ornamental fronts for balconies, and in the open ornamental panel work so much employed in the large entrance gates or "portes cochères" of dwelling houses in Paris, as also in small ornamental work which is introduced with good effect under the soffits of window openings, and also across the lower parts of the French windows, forming at the same time a precaution against accident, and a very effective decoration.

Zinc.

Zinc is also a metal that enters much more largely into construction in France than in this country, where indeed it has been to a limited extent employed, instead of slate or lead, as a covering for roofs, but not with such success as to warrant its general adoption for that purpose ; in France it is now very largely used for this purpose, and seems to give satisfaction, as its use is being continued in almost all the houses now in course of construction in Paris. French builders give as a reason for this difference in the durability of sheet zinc, that in England it is used much too thin, but probably it may be better accounted for by the superior dryness of the Paris atmosphere, and its comparative freedom from the acids contained in the products of the combustion of coal, and from any saline particles that may enter into the composition of the air in England from greater proximity to the sea.

Stamped zinc also appears in a variety of forms, both of ornament and utility, as for instance, in brackets, columns, mouldings, pinnacles, balustrades, and in ornamental tile-shaped plates for roofing, exhibited by the Vielle Montagne Company and by Messrs. Grados and Fugin of Paris ; it is also shown by a number of French makers in different patterns of crest ornaments for roofs, and in the small open work fringe-like ornament which gives such a neatness and finish to the eaves of the roofs of little verandahs and porches, and which every one must have remarked as constituting quite a feature in the street architecture of Paris and its suburbs, as a border for signboards, and applied to every variety of use. Prussia sends some very light windows in

Zinc windows.

this material, the whole frame, styles, &c. being formed of hollow drawn zinc (zinc tiré), a French casement window of this kind, 8 feet by 3 feet 6 inches, is marked at 25*s.*, including the espagnolette or fastening, and a semicircular fanlight of 3 feet radius at 10*s.*

Small zinc plates of different patterns, to be used as tiles, are found in several instances in the Exhibition, but, except for portability, their advantage over ordinary zinc roofing is not apparent, as the number of joints in the covering, and consequently of places to keep water-tight, is much increased, without any corresponding benefit being derived from the employment of such a roof; the best of them are, perhaps, by Levayer (Vaugirard), who has zinc tiles, if the term may be used, 2 feet square, with a copper hook on the back for the purpose of fastening, and with a raised edge lapping over a fillet.

Zinc nails for slating are exhibited by the Vielle Montagne Company, as a substitute for iron or copper.

Architectural zinc work.

One of the best examples of architectural zinc work is contributed by Prussia; it is an octagonal lantern of the geometric period of mediæval architecture, surmounted by a crocketed pinnacle pierced with small openings. The lantern has a two-light opening in each side, with a quatrefoil in the head; the whole is of thin hollow zinc, and is 20 feet high by 4 feet in diameter.

Lead.

Lead does not appear to be brought forward as a covering material, but as an element of decorative or ornamental construction, it is shown by several exhibitors. Some of the most remarkable objects of this kind are, perhaps, those by M. Durand, Paris, who contributes examples of colossal statues, crocketed finials, grotesque gargoyles, and other objects for the external decoration of ecclesiastical structures, one of which, a very florid finial about 25 feet high, ornamented at its point with flowers and balls of coloured glass, is intended for one of the chapels of Amiens Cathedral which is in process of restoration. One of the remarkable points about these ornaments is, that they are entirely in hammered or repoussé work.

Repoussé lead work.

A M. Lebel has also some good repoussé lead work of a similar character, intended apparently for the roof decoration of buildings in a mediæval style, such as a very elegant open crest or ridge ornament, some pinnacles, and other objects of a like character.

Wood.

Considered as specimens of timber for construction, the Canadian collection, both of woods, and articles manufactured from them, stands unrivalled in the Exhibition for the magnitude and beauty of the examples of the raw material,

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and the eminently practical character of the entire collection. These woods are shown both in the rough and also in an immense variety of different objects into which they have been converted, and many of which are remarkable for the extremely low prices at which they can be sold; as, for instance, an interior door, 6 ft. 6 in. by 2 ft. 9 in., of white pine, four-panel square, with jamb-linings, &c. complete, for $2.75 or 11*s.* 5½*d.*; another, same size, four-panel, moulded both sides, with jamb-linings, double rebated, and beaded, for $3.50 (14*s.* 7*d.*); also a sashframe and sash, 6 ft. by 3 ft., $2.0 (8*s.* 4*d.*); and outside Venetian shutters or jalousies for the same, $1.50 (6*s.* 3*d.*) The woods from some of the other British Colonies are also deserving the attention of builders and constructors in this country, more especially those sent from New South Wales, British Guiana, and Jamaica, the results of some experiments upon the strength of which have been already published in the first part of the Reports on the Paris Exhibition, and from which it appears that out of 79 different kinds of wood experimented upon, 42 exhibited a capability to resist a crushing strain superior to that of oak, one having three times the strength of oak in this respect, while its specific gravity was less than one-half greater, or nearly as 11 to 8. Forty-seven of these timbers proved superior to oak in bearing a transverse strain, some of that number being at the same time of a less specific gravity A large collection of woods appeared also from Algeria, but none of them of such a character as to come within the limits of this Report, being almost, without exception, more calculated for small work and furniture-making than for purposes of construction.

M. Boucherie's process for preserving wood.

When on the subject of woods, it is necessary to allude to the process of M. Boucherie for the preservation of timber destined to be exposed to the action of the weather or buried in the ground. In the garden behind the Palais de l'Industrie, several railway sleepers were exhibited, each pair cut from the rough trunk of a tree, and in each case one of such pair had been submitted to the process in question, which consists in injecting sulphate of copper into the pores of the wood. The sleepers exhibited are said to have been all buried side by side for nine years; and they certainly presented a very remarkable contrast, those which had been operated upon by M. Boucherie being perfectly sound, while the remainder were as entirely destroyed and useless. The cost of the process is said to be something under 4¼*d.* per cubic foot; and one of the advantages claimed is, that it will give the means of employing, for railway sleepers and telegraph posts, woods that are cheaper and have hitherto been reckoned worthless,

instead of the more costly descriptions now used for those purposes.

It is much to be regretted that no model appears in the Exhibition of any of the numerous French bridges in which wood has been so extensively and cleverly employed, the only examples of wood being so used being some few models of propositions and untried schemes.

Messrs Nepveu showed a model of a fine piece of carpentry, being the roof of their workshops at Clichy ; it has a span of 53 feet in each direction, and is remarkable for the very small scantling of the pieces of which it is composed.

A very novel and curious form of roof is shown near the one just mentioned, by a M. Mehedin, of Paris ; it is a semicircular arch or vault, and is composed entirely of lattice work of battens apparently about 6 in. by $1\frac{1}{2}$ in. or 2 in. ; there are no principals or any timbering of any kind, but the whole roof is kept in form by a number of wrought iron radial tie rods proceeding from the centre of the semicircle, each rod branching into four about halfway between the centre and circumference, and having the ends of these branches attached to the lattice work at equal intervals ; the appearance of the roof is extremely light and pleasing, but whether it has ever been applied does not appear.

The classification now goes on to the enumeration of the different arts and trades appertaining to construction, which it takes in the following order, viz. :—

Earthwork.

Section 2. Earthwork.

Navvies' tools, such as crowbars, sledge-hammers, wedges, pickaxes, &c.

Mining tools, pushpicks, prickers, ladles, safety-fuses, and all tools for boring and blasting.

Blasting by the galvanic battery, extraction of rocks under water.

Earthworking machines.

Plans and arrangements of plant and workshops for earthworks.

Masonry.

Masonry.

Masons and stonecutters' tools, instruments, and apparatus.

Specimens of stonework, masons' work, &c.

Marblework.

Marblework.

Tools and instruments employed, samples of marble as sold for constructions.

Specimens of marble work, such as chimney-pieces, table tops, consoles, &c.

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There were some good examples of mining and well sinking tools and apparatus; those of the former kind come more properly under the notice of the jury on mining and metallurgy, and have accordingly been dealt with by them. Two complete sets of well sinking apparatus were shown, one full size, the other in model, and were such as have been used in sinking artesian wells.

Tools for earthwork did not appear at all as a class by themselves, but were exhibited by several countries as agricultural implements, and as such also entered into the list of objects examined by another jury from that of Class XIV.; the same may be said with regard to igniting charges of gunpowder by electricity, apparatus for submarine work has been already treated of in speaking of Class XIII.

There is no contribution of any plan or arrangement of a workshop connected with the execution of earthwork, so that passing over the subsections containing those subjects, we come to that paragraph which treats of masonry and stonecutters' work, the best expositions of which, as far as France was concerned, were given in the various masons' work which was carried on at various parts of the Exhibition during the period immediately preceding and for some time after the opening; and it may be remarked, that there is a very wide difference between the manner of working of an English and French stonemason; for while the former makes use exclusively of his trowel for taking up and laying mortar, using his hand merely in placing and arranging the stone, a French workman takes up a trowel full of mortar in one hand and a handful in the other, and really, to see him at work, the first impression is that his trowel is a mere auxiliary, and that the principal part of the work is done with the other hand; their work, nevertheless, is remarkably good and firm, part of this, however, may be attributed to the admirable mortar which they employ, and to the ease with which the stone generally used is capable of being brought into any required shape.

Stone-cutting machines.

There were two stone-cutting machines in the Exhibition, the invention of Frenchmen, and which were both shown at work, and it may be observed, with regard to their appearance and mode of action, that no two machines for the same purpose could differ more widely. The one being cumbrous and heavy in appearance and slow in operation, and the other distinguished in a remarkable degree by its simplicity and rapidity of action. In the first, the stone is sawn into the required form by means of two or more up and down saws having coarse projecting

teeth, which are capable of being removed for repair or renewal; and in the second, the operation of sawing is effected by a thin iron wire running over the stone at the rate of 40 feet a second, and kept constantly supplied with water and sand. Samples of its work in granite, agate, and glass were exhibited, but its rate of cutting was unfortunately not tried during the time that it was at work in the building.

Stone carving.

The specimens of carving in stone and marble are very numerous and beautiful; the only specimens, however, sent by England are those alluded to in speaking of building stones, viz., the altar and reredos by Messrs. Gates and George, which is most beautifully and delicately executed, and which was unfortunately much broken and injured in the transport from London, the marble chimney-pieces of Mr. Costello, and the collection of articles in lizard serpentine. The stonework intended for Cologne Cathedral, exhibited by Prussia, has also been mentioned among the raw material.

A number of beautifully wrought altars in marble filled the great nave, and at one part the same material was shown in a somewhat novel form, namely, that of the frame of a toilet glass, in which, whatever may be thought of the purity or beauty of the design, or the fitness of the application, there can be but one opinion as to the workmanship, which is all we have to deal with in this place. A large tazza of polished granite, which stood in the garden behind the Palais, showed some beautiful work, and there were good specimens of a less elaborate kind in some carved stone garden seats and chairs in the Austrian section; and chimney-pieces of all colours and shapes were found in every corner, but none possessing anything extraordinary as workmanship.

The next in order in the classification is

Carpentry.

Carpentry.

Carpenters' tools and scaffolds, fixed, moveable, and suspended. Systems of carpentry roofs, centres, stairs, &c.

The class of wood-working machines, which were tolerably well represented, can only be glanced at here as belonging more properly to Class VI., but one in particular may be mentioned as being a novelty in this country, although a good deal used in France, viz., an endless or ribbon saw (scie sans fin), in which a very fine endless saw, not more than $\frac{1}{4}$ inch wide from front to back, works like a strap over two wheels or pullies; it is an improvement on a reciprocating saw, inasmuch as there is no up stroke, the saw

being always cutting, and consequently saving half the time of the former, and it possesses the advantage over the circular saw of being capable of cutting the sharpest curves; it was shown at work during the Exhibition, and was accompanied by specimens of work of a most elaborate kind performed entirely by the saw.

Among the many examples of carpenters' tools in the Exhibition, may be noticed a plane in the French part, in which the wedge is made of two plates of iron hinged together at the point, and kept open to a wedge form by a screw through one of them acting on the other; the wedge, on being placed in the plane by the hand, can thus always be tightened or loosened by a turn of the screw, without being obliged to have recourse to the clumsy expedient of knocking with a hammer. It is to be regretted that no models or designs were shown of the French method of scaffolding, which differs in many points from that in use in this country; it is entirely of squared timber, and put together with bolts and nuts, and instead of ladders regular stairs are constructed in different parts of the scaffold itself; ready means of ascent and descent are a point of more importance in France, from the fact of the substitution, in a great degree, of manual labour for mechanical means in raising material to the work; to such an extent is this carried, that in the construction of a wall 50 feet in height, which was erected at the request of the British Commission between the building devoted to the exhibition of Fine Arts and an adjoining sugar refinery, the stones of which it was composed were handed up from man to man by men placed on a ladder and along part of the scaffold, and 20 men were constantly so employed. A sort of travelling scaffold was exhibited by Messrs. Nepveu, the contractors for works in the Annexe or machinery building, but which was more for the purposes of a crane or gin than a scaffold; it consisted of a cross-beam supported by four legs, two at each end, diverging outwards, and having a wheel about 2 feet 6 inches in diameter at the foot of each leg moveable like a castor, and on which it travelled; it was a good deal employed in raising some of the heavy French machinery, and seemed to answer its purpose well; it was remarkable for the lightness of scantling of the pieces of which it was composed, a principle which seems to characterize M. Nepveu's works in carpentry. Several small pieces of scaffolding were, during the Exhibition, from time to time erected in the course of the works, and all displayed great ingenuity and cleverness in adaptation of general rules to special cases.

Smiths' Work.

Smiths' work.

Coverings of roofs, floors, girders, isolated supports, &c.

Door and window fastenings, glass partitions, open iron-work for panels, &c., shop fronts.

Joinery.

Joinery.

Systems of doors and windows, shutters and blinds, parquets (flooring in patterns), mouldings, &c.

Painting and Glazing.

Painting.

Samples of work; windows, glass roofs, panels painted in imitation of wood, marble, and other materials.

Asphalte.

Asphalte.

Employment of asphaltes and bituminous mastichs.

Coverings of terraces and walls.

Mosaic pavements.

Pattern flooring.

Employment of bitumen for flooring, mosaic, &c., which concludes the list of the various arts appertaining to construction. Almost all the objects under these several heads, that presented anything especially worthy of notice, have been already described when speaking of the various classes of materials to which they belong, and of objects exhibited as actual samples of workmanship, the description would be little more than a mere list, and would possess little of either interest or value. It may be mentioned that the exhibition of wooden floors, in ornamental patterns, was very varied, and some of the specimens very handsome and well executed; one part of the nave of the Palais de l'Industrie was floored with oak in pattern, the pieces being laid on the ground in hot asphalte, without joists, and of course without nails or fastening of any kind; this seems a cheap and simple way of laying a wooden flooring on the ground, but it is probable that the wood would speedily be destroyed by the want of ventilation underneath. Some of the Belgian examples of parquetrie floors were particularly beautiful, and many of them at prices much lower than might have been expected for work of that class; the principal wood employed in their construction, and in fact the wood generally used in all French and Belgian floors and house joinery, is a straight grain wainscot or oak; the relative values of oak and fir being very different on the Continent from those usually quoted in this country. The exhibitor of the cheap Canadian doors and windows already mentioned, stated, through his agent, that he can deliver on board ship at Montreal, flooring board, of black walnut,

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(a beautiful wood, susceptible of the highest polish, and of which some fine samples were shown in the Canadian collection,) inch thick, at 2*d.* per foot super.; and in that case there seems to be no reason why architects and builders in this country should not avail themselves of this valuable adjunct in interior decoration, in situations such as halls, public rooms, &c., where carpets are not used, and where a parquet floor would form a valuable and legitimate element of decoration.

Some panels, painted in imitation of different woods and marbles, shown by two English exhibitors, Moxon and Kershaw, were admirable specimens of graining; but these, together with the subject of marble and stone carving, and many other subjects in the same class, have been already so ably treated by Mr. Digby Wyatt, in his report on the 24th class, that it would be superfluous to give them more than a passing notice in the present Report; the same may be said with reference to mosaic work, which is the last object in this section, and which brings us to the consideration of the fourth subdivision of the XIV. class, viz.—

Foundations.

Section 3. Foundations.

Foundations on concrete, on blocks of natural or artificial stone, on gravel and sand.

Systems of piling, cofferdams, caissons.

Pile-driving, cutting and drawing machines (except those treated of in class VI.)

Pneumatic apparatus, metal cylinders and caissons.

Diving bells, submarine boats, instruments and apparatus for submarine foundations.

The foundations of the principal works exhibited will be found in the general description of the works themselves, among which those of the viaduct over the Durance, the lighthouse of Brehat, the viaduct of Tarascon, present the greatest peculiarities in this respect.

Screw piles.

In the second subdivision may be mentioned the screw piles of Messrs. Saunders and Mitchell, several modifications of which were exhibited full size, and attracted considerable notice from continental engineers. The ordinary screw pile is entirely of wrought iron, and consists of a pile about 6 inches in diameter, with a disc about 4 feet 6 inches in diameter at its lower extremity, forming a single turn of a screw, and terminated by a screw or gimlet point of the diameter of the pile. Another form is that which has been employed at Portland, and in which the pile itself is wood, the screw termination only being of iron, and somewhat different in form to that

just described; in this the screw has four turns, and begins at about 2 feet 6 inches from the extremity, with a diameter of 2 feet 3 inches, and is gradually reduced to nothing at the point of the pile. Two models, which are described further on, are exhibited to illustrate the application of the screw pile to the construction of lighthouses, viz., the Gunfleet and Maplin Sand Lighthouses.

Cofferdams. Cofferdams do not seem to be represented in the Exhibition, but in several of the works caissons have been used, perhaps the most important in size being that of the sluice or lock at Stockholm; and in connexion with the same work may be mentioned the apparatus used by Mr. Ericson the engineer, in cutting off the piles to the proper level; it consists of a hollow cylinder of wood, which is let down over the pile, and into which the top of the pile enters; a short thick curved saw with four teeth is fastened inside the cylinder by a pivot through one end, and furnished with a strong spring to press it forward against the pile, which is itself pressed against the saw by a similar spring acting in a contrary direction; these springs being released, it only remains to give the cylinder a horizontal rotary motion till the pile was cut through; the time necessary for the operation being somewhat less than an hour for a pile 12 inches in diameter, and the number of men employed, six.

Mr. Redman's Terrace Pier. As an example of the employment of metal cylinders for constructing foundations may be cited the Terrace Pier at Gravesend, a model of which is exhibited by Mr. Redman, C.E. The cast iron columns of which the pier is composed are bolted down to a block of stone, resting on a pier of brick set in cement, and these foundations were executed by the aid of cast iron cylinders 6 feet in diameter, which were placed one over the other in rings 5 feet deep, and loaded, until the lower cylinder was firmly embedded in the chalk, having passed through the successive strata of mud, sand, gravel, and boulders, of which the bottom is composed, the weight necessary to drive them being from 5 to 20 tons; the water and mud being then removed from the interior, the masonry was completed, and the cylinders, with the exception of that at the bottom, withdrawn; at the head of the pier, where a greater depth of excavation was necessary, a second cylinder 7 feet in diameter was used outside of the other, to relieve the latter of the pressure consequent on the increased depth.

Pneumatic apparatus for foundations. Pneumatic apparatus for submarine foundations are almost all treated of in other classes, under the head of diving bells, diving dresses, &c., and do not offer much of novelty, if we except the apparatus made use of by Mr. Brunel for

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the centre pier of Saltash viaduct; in this case it was necessary, to arrive at the solid rock, to descend 64 feet below low water, passing through a stratum of mud 10 feet thick, and to execute the masonry at this depth, a cylinder of plate-iron 35 feet in diameter, and of sufficient height to reach the surface of the water, was sunk at the spot determined on; this cylinder was separated into two parts at about a third of its height by a hemispherical partition, the lower part having a second cylinder inside dividing it into a circular chamber, and an annular space, each communicating with the surface by separate tubes or shafts; the water is expelled from the latter of these spaces by pumping air into it, and the masonry is executed under a pressure of from 3 to 4 atmospheres.

The next section (No. 4) of the classification is occupied by works relating to maritime navigation, which are enumerated in the following order:—

Works relating to Maratime Navigation.

Section 4. Maritime works.

Plans of roads, harbours, and basins.
Lighthouses and signals.
Protection of banks, by post and fascine work, groins, scouring sluices, &c.
Breakwaters, piers, jetties.
Quays, docks, and basins.
Building slips and dry docks.
Stores and warehouses, floating docks.

Model of Calais.

The only model of a harbour entered in the French catalogue is that of Calais, which, although classed with civil engineering, comes rather under the head of mechanical toys, and is of no value whatever as a model of a work.

Great Grimsby docks.

England sends two well-executed models of docks or harbours, one of Great Grimsby docks by Mr. Rendal, and the other (which was unfortunately much injured in transit) of the new harbour and docks at Sunderland by Mr. John Murray, so well known for his admirable and successful translation of the lighthouse at the same place. The superficial content of the new basin at Great Grimsby is 25 acres, with an aditional 5 acres for timber; it is surrounded by extensive wharfs, on which are laid lines of railway, affording easy communication between the warehouses, ships, &c., the cranes on the wharfs are all worked by hydraulic pressure, for which a handsome square tower, 300 feet high at the entrance of the dock, serves as an accumulator. There is an outside harbour, protected by two wooden jetties, whose superficial content is about 15 acres.

Sunderland docks.

The Sunderland docks consist of six basins, whose united areas amount to 60 acres, the wharfs and quays by which they are surrounded occupy an area of 70 acres, the entire space being thus 130 acres, of which 110 acres have been reclaimed from the sea; the depth of the principal basin is 24 feet at high water; railways are carried along the quays in every direction.

Lighthouses.

Models of lighthouses are to be found in both the French and English parts of the Exhibition, the latter containing three samples, all by Messrs. Walker and Burgess, viz., the Bishop's Rock lighthouse in masonry, and those of Gunfleet and Maplin Sand, constructed of iron on screw piles. One of Mr. Gordon's cast-iron lighthouses, of which several have been erected in the colonies, would have been a valuable addition to this branch of the subject, of which the entire Exhibition could only number four examples.

Maplin Sand Lighthouse.

The Gunfleet and Maplin Sand lighthouses are constructed on Saunders and Mitchell's screw piles, and are types of a class of which several others have lately been erected in different parts of the kingdom and colonies, that on the Maplin Sand having been the first. It is supported on nine screw piles, 30 feet long, which are driven 22 feet deep in the sand, one in the centre and one at each angle of an octagon 40 feet in diameter. At the surface of the sand the piles are surrounded by a timber grating covered with fascines and ballasted with stone. The piles are prolonged by hollow cast-iron pillars connected with each other by wrought-iron tie-rods; these pillars are carried up vertically to high-water mark, from which point they converge inwards till they reach the bottom of the platform, 22 feet in diameter, upon which the light chamber stands. The total height from the lower end of the piles to the top of the light chamber is 86 feet, and the elevation above high water is 48 feet. In the Gunfleet lighthouse the wooden grating is dispensed with, and the piles are simply connected by cross ties of iron. The screw pile lighthouses have generally been erected to replace light vessels or to afford a refuge for pilots at the entrance to ports and harbours, and where they have been tried, are said to have produced a considerable saving in the yearly expenses.

The only other lighthouse in the Exhibition is in the French department, and of which there are three admirable models, one showing the edifice complete, a second being a vertical section, and the third a horizontal section through the foundation, showing the method of construction and the arrangement of the stones in each course of masonry.

French lighthouse, "des Heaux des Brehat."

The lighthouse of the "Heaux de Brehat" is erected on the rocks of the same name, which are situated off the coast

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of Brittany, at about ten miles from the town of Lazardrieux; it shows a fixed light on Fesuel's system, which can be distinguished at a distance of 20 miles. The rock on which it is built is covered at high water to a depth of 15 feet, so that the whole of the foundations and lower part of the edifice were necessarily tide work, the rock, which is an extremely hard black porphyry, having been excavated to a sufficient depth to secure a perfectly solid surface, an annular cutting of 2 feet deep by 4 feet wide, and with a diameter of 45 feet, was made in the rock to receive the outer stones of the first course of masonry. The masonry of the lower part of this lighthouse is not solid throughout, nor are any iron cramps employed, as in the Eddystone and other English lighthouses, to the former of which it has been compared by some French engineers, but with which the totally different circumstances of position forbid all analogy. In the first four courses, or to a height of about 6 feet, the masonry consists of an exterior ring about 7 feet thick, containing 48 voussoirs, each fourth one of which runs in radially to a length of 15 feet from the face, dividing the ring into 12 equal segments, and connecting it to an inner ring about 3 feet thick and 13 feet interior diameter, the spaces between the rings, as well as the centre of the inner one, being filled in with concrete about the height of 6 feet. From this level the two rings are carried up in one ring of about 12 feet thick, and the centre filled in with concrete up to the level of the entrance door, which is 3 feet above high-water mark at spring tide, or 18 feet from the rock. The 12 keys in each course are joggled by granite joggles to the course below, and are sunk at the joints to receive corresponding projections in the adjacent stones of the course, so that each segment is tied in separately; this method was adopted so that each segment, being perfect in itself, might be completed and secured in one tide. This mode of construction was continued up to a level of 18 feet above high-water spring tides, above which the walls were carried up in ordinary ashlar work, care having been taken to employ only the best materials both of granite and cement. The stones employed varied from one to three and a half tons in weight. Granite was used for the entire construction with the exception of the vaults of the several stories, which were turned in brick. The work was much facilitated by the circumstance that a small part of the adjacent rock was uncovered at high water, and that a depôt was thus obtained at which the materials could be collected close to the work, and at which cranes could be erected to aid in their disembarkation, &c.

The diameter at the base is 45 feet, which diminishes to 30 feet at a height of 25 feet, with an elliptical profile;

above that it is carried up nearly perpendicularly to a height of 60 feet, where it is terminated by a bold cornice and ornamental stone parapet, the diameter at this point, exclusive of the cornice, being 28 feet. From this springs a tower 21 feet 6 inches in diameter at the base, 19 feet 6 inches at the top, and 90 feet high, surmounted by a machiolated cornice and stone parapet. The masonry base of the lantern, 13 feet diameter and 6 feet high, springs from the gallery thus formed, above which rises the lantern itself, 10 feet diameter and 18 feet high, thus making the total height above the rock 175 feet, and from high-water spring tides 160 feet. The building is divided into eight stories exclusive of the lantern, and is ascended by a small newell stair at one side; its construction occupied five years.

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A drawing of the port of the Joliette at Marseilles, the models of the New Holland and Gravesend piers, and a small model, unaccompanied by any description, of a floating dock in the French part of the Exhibition, complete the list of objects that come under the head of this section. The pier of New Holland on the Humber, opposite Kingston-on-Hull, has been constructed by Mr. J. Fowler for the Manchester, Sheffield, and Lincolnshire Railway; it is constructed principally of wood, and is the largest construction in carpentry in the Exhibition. The Terrace Pier has been already alluded to in speaking of the foundations, and is besides so well known in this country as to render any further description superfluous. The next division of the subject is Section 5, which contains—

Port of the Joilette. New Holland pier.

Works relating to Inland Navigation.

Section 5. Inland navigation.

Plans and sections of canals and rivers.
Embankments and defence of banks.
Feeding canals, reservoirs, dams, sluices.
Locks, gates, inclined planes, apparatus for raising and lowering boats.
Aqueducts.
Dredging of harbours, rivers, canals, &c., systems and apparatus.
Passage of rivers.
Transport by water, floating trains, &c.

There is only one work exhibited by England, the aqueduct on the Aire and Calder canal, which is connected with the subject of inland navigation, while the French collection, on the contrary, is especially rich in this class of construction, more particularly in dams or barrages across navigable rivers, of which there are several models on a good scale from the "Ecole des ponts et chaussées." The cast-iron aqueduct over the river Calder, by M. Leather, is repre-

Calder aqueduct.

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sented in a very carefully executed model by Mr. Salter of Hammersmith (who is also the constructor of most of the other English models, including the minutely intricate one of the New Holland pier, the Saltash and Chepstow bridges, &c.); and perhaps none of the English works attracted more admiration from the profession in France, not so much for its beauty in an engineering point of view, as for its "happy application of Greek architecture." This is the more strange, as it is the one point in which the true principle of architectural fitness has been rather lost sight of.

This aqueduct, which is of but one span or arch, is composed of two ribs of cast iron, from which the trough, also of cast-iron, is suspended by wrought-iron rods, after the manner known as the bowstring bridge; it has a span of 156 feet, and carries a canal 9 feet deep and 24 feet wide, and on each side a tow path 3 feet wide. The weight of water supported is 950 tons, and the total weight of iron employed is 770 tons.

The model of the head works of the great Ganges canal, sent from the Thomason College at Roorkee, in the north-west of India, may be said to come into this section.

Locks at Montreal.

Canada, always represented in every class, has also some models of lock-gates, with improvements in the working of the valves or sluices, and a model of the locks and basin on the Lachine canal at Montreal, which were constructed in 1846, and are capable of receiving a vessel 180 feet long, 44 feet beam, and 16 feet draught of water; they are executed entirely in granite ashlar.

Holland.

From Holland there is a model of a floating dock, unfortunately without explanation, as well as one of the sluice at Flushing, as reconstructed in 1848, and of a caisson for closing the entrance to a dock or basin, the peculiarity of which consists in its being furnished with a pair of gates in the centre, so that small vessels can be admitted without the necessity of removing the cassoon.

Sweden.

Sweden also contributes some very beautifully executed models, one of the falls and locks of Trowhatta, which is, however, necessarily on such a small scale, from the extent of country which it takes in, as to be more valuable in showing the natural difficulties overcome than as any record or illustration of the engineering works themselves. A second model illustrates a peculiar kind of drawbridge for canals, invented by a M. Hanson; and the third and

New lock at Stockholm.

most important one represents the new lock at Stockholm, which forms the communication between the Moelaren Lake and the Baltic; it was undertaken in 1847, to replace a former one of insufficient size, and finished in 1850, under

the auspices of M. Ericson, brother of the well known inventor of the air engine in New York.

The new lock measures 150 feet in length from gate to gate, and is 32 feet in width at the gates, and 37 feet 3 inches wide midway between these points, the side walls being curved outwards to that extent; at each end of the lock, on the outsides of the gates, drawbridges are constructed to afford communication between the opposite banks. The difference of level between the lake Moelaren and the Baltic is only 2 feet 6 inches, a circumstance which relieved the engineer of much difficulty; in the construction of the lock more serious obstacles, however, presented themselves, in the general character of the ground, which was found to be composed of blocks of stone, sand, débris of masonry, &c., and in the difference of level between the different parts of the bottom, of which the highest point was only 2 feet below the water level of the lake, while some points of the site reached a depth of 30 feet below the same level. The ordinary modes of proceeding with the construction of foundations having been rendered unavailable by the nature of the soil above mentioned, M. Ericson conceived the idea of building the entire lock with its foundations, floor, gates, and retaining walls in one great caisson of woodwork, a method which has many times been adopted for piers of bridges, but of which the magnitude of the present case rendered the attempt somewhat bold.

The soil was first removed in that part of the site which was above the proposed level, and the lower part raised to that point by means of large piles driven as close together as possible, cut off to a level and filled in with the excavation from the upper part; the extremity of this embankment towards the Baltic was protected by a sea wall of rough pieces of rock, and towards the lake was driven a row of sheet piling extending across the entrance of the lock.

The caisson, which was built in a dry dock, measured 262 feet in length, 55 feet in width, and 21 feet in depth, the timbers of which it was composed being 12 inches square; it was floated out like a ship, and towed into its destined position over the piles, the masonry was then commenced and carried up in the interior (care being taken to secure a regular and level sinking of the caisson), beginning with the floor, and then the retaining walls and other parts of the lock.

The drawbridges are alike in every respect; they have each 26 feet 6 inches width of roadway, and are divided in the middle, each half rises on a horizontal axis, the ribs of iron of which it is composed being carried out to the rear, to serve as a counterpoise, which is made variable by means of

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heavy weights slung to the ceiling of the vault in which the counterpoise moves by chains of different lengths, and which consequently are lifted in succession by the counterpoise, and gradually increase its weight as the bridge approaches a horizontal position.

French models.

We next come to the French collection, and first, both in the size of the model and the importance of the construction itself, stands the aqueduct of Roquefavour, which is one of the principal works on the line of the canal that supplies the city of Marseilles with water; this canal was originally undertaken for the purposes of irrigation, and was afterwards diverted to its present use, its total length is 60 miles 5 furlongs, in which course the difficult nature of the country through which it passes rendered necessary the construction of no less than forty-five tunnels of various lengths, besides numerous aqueducts, the principal of which is that which spans the valley of Roquefavour, and which has a total length of 1,420 feet, and a height above the lowest water level of the river of 272 feet, its breadth at the base is 46 feet 10 inches, and at the level of the water course 14 feet 10 inches; it is composed of three different stories or ranges of arches one over the other, in the two lower ranks the piers are directly over each other, forming bays of the same width from centre to centre of the piers, the arches of the lower rank having a somewhat less span than those of the second, owing to the increased thickness of the piers between them. In the third or upper row there are three arches to each bay of the two lower stories, every third pier being a continuation of that of these other ranks; the dimensions are as follows:—In the lower rank, 12 arches with a span of 49 feet 6 inches each; in the second rank, 15 arches with a span of 52 feet 10 inches each; in the third rank there are 53 arches of 16 feet 6 inches span, which support the conduit.

Aqueduct of Roque-favour.

The heights are as follows:—

	ft.	in.	ft.	in.
From the low-water level of the river to top of plinth - - - - -	16	6		
From top of plinth to springing of lowest arch - - - - - -	61	0		
From springing to crown of do. -	24	9		
From crown of arch to level of first stage	11	6		
From water to coping of first stage -			113	9
From first stage to springing of second arch - - - - -	76	6		
From springing to crown of do. -	26	6		
From crown to coping of second stage -	14	10		
Height of second stage - -	118	10		

	ft.	in.	ft.	in.
From water level to coping of second stage			232	7
From coping of second stage to springing of third arch	13	2		
From springing to crown of do.	8	3		
From crown of upper arch to coping of conduit	13	3		
Height of third story	34	8		
From water level to coping of conduit, total height			267	3

The piers are perpendicular on the faces, and of the same dimensions from the springing of the upper arches to the coping of the lower story or stage, measuring in the transverse section of the aqueduct 14 feet 10 inches by 16 feet 6 inches in a longitudinal direction; at the latter level the transverse measurement is increased by an offset at each side to 18 feet 2 inches, and from the springing of the lower arch the inner faces have a batten of 10 inches each, making the dimensions of the pier at the top of the plinth 18 feet 2 inches by 16 feet 6 inches. The piers are each strengthened by counterfort 9 feet 9 inches wide, with a projection of 11 feet 6 inches at the plinth, and battering inwards until it dies out under the upper cornice of the second stage. The conduit carried by this enormous mass of masonry is 8 feet 3 inches in width, and the depth of the water in it is 4 feet 8 inches. The preparatory works of this aqueduct were undertaken in 1840, but the actual construction did not commence until 1842, and it was finished in 1847. There were employed in its construction 42,000 cubic feet of wood, 640 tons of wrought iron, 180 tons of cast iron, and the stone used amounted to 580,000 cubic feet of rubble masonry, and 750,000 cubic feet of ashlar, and the total expense was 148,000*l.*

The piers all rest on solid rock, some of them having been excavated for to a depth of 35 feet. The cut stone was brought from a quarry four miles distant by a railway, and was drawn by a waterwheel up an inclined plane to the level of a second railway, which ran the whole length of the bridge; this was supported by the centres until the first set of arches was turned, after which it was carried along on the top platform of the first story, and in like manner for the remaining two stages of the work. During the building of the piers a moveable flying bridge was established, by which a communication by a railway was maintained from pier to pier. The arches are all semicircular, the masonry

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is ashlar, rough, hammer-dressed on face, and with rusticated joints; the blocks employed varying from 35 to 200 cubic feet, or from 2½ tons to 15 tons in weight. The conduit is formed in brick and cement. The pressure on the foundation of the highest pier is stated to be about 30 tons on each square foot, and the ratio of the mass to the weight supported is nearly as 600 to 1. Besides the large model of a portion of the aqueduct as completed, a second, of one arch only, on a still larger scale is exhibited, for the purpose of showing the details of the centreings, and the construction and method of working of the small railways mentioned above; this last model is much more useful and explanatory than such things generally are, as it is almost what might be termed a working model, and the scale cannot be less than one-tenth of the actual size. The other aqueduct, of which a model is shown, is a moveable aqueduct over the Libron, which is so constructed that the trough, which is only just above the level of the water, can be removed at pleasure; which arrangement was rendered necessary by the torrential nature of the small river Libron.

Aqueduct of the Libron.

Barrage of Gros-Bois.

Of dams or barrages, the most important is, perhaps, that of the reservoir of Gros-Bois, on the Canal de Burgogne, a large drawing of which appears among the models; it is entirely of masonry, and consists of a revelment with a batter of 1 in 20 on the face, and with five steps or offsets at the back, where it is further strengthened by a series of counterforts nine in number, and filled in behind with earth. The total length of the wall, from one side of the valley to the other, is 1,795 feet, of which a length of 320 feet at one end and 316 at the other are left without counterparts; the first two of which at either flank are 200 feet apart, and the remainder at intervals of 130 feet. The height of the wall over the footings, at the highest part, is 73 feet 6 inches, the height of the footings is 17 feet, and the breadth 52 feet. The thickness of the wall is 42 feet 9 inches at the bottom, and 21 feet 6 inches at the top, there being five offsets of 4 feet 3 inches each at the back.

Moveable Dams.

All the other barrages or dams are moveable, and are divided into three classes, viz., those on the system of M. Poirée, in which the dam is removed by hand in small pieces; those by M. Thenard, where counterpoises are made use of to facilitate the raising and lowering of the dam; and a third kind, invented by M. Chanoine, in which he makes use of the rising of the water itself to lift and so open the dam, which is thus made self-acting. In a model of a barrage on M. Poirée's system, the fixed or permanent part consists of a sill of wood at the bottom of the river, reaching from side to side, which is kept in its place with masses

of hydraulic mortar, and to the upper side of which is attached a small projecting ledge of iron throughout its entire length; another frame or sill, supported at intervals by stanchions firmly strutted in rear, is carried across the river parallel to the first, and at a height of some feet above the water; and the dam is formed by a number of small baulks of timber which are placed vertically, the lower ends resting against the iron ledge, and the upper part being supported by the upper frame or sill; the baulks are lashed together in sections of 6 or 8, for convenience of handling and removing. Another model shows a moveable barrage made of plate iron of two thicknesses, with cellular divisions between them; it is curved in the arc of a circle, to the centre of which it is connected by iron radii, or it may be better understood by supposing it to be a segment of about 60° of a vertical wheel on a horizontal axis, and its motion in being raised or lowered is a circular motion on its axis. Another kind of dam is exhibited by M. Louiche-des Fontaines, and there are besides in this section a model of the scouring sluice at Dunkirk, of the lock of St. John at Havre, of the lock near the Mint in Paris, and of a draw-bridge without a counterpoise by M. Davaine.

7th Section.—Roads and Railways.

Section 7.

Plans and sections of roads, systems of construction.

Material for the construction and repair of roads, whether paved in stone or wood, macadamized or asphalted.

Apparatus for sweeping and removing mud.

Accessories, seats, fountains, mile-stones, finger-posts, &c.

Plans and sections of railways, systems of construction.

Objects relating to laying the rails, sleepers, chairs, rails.

Turntables, traversing tables (except when treated of in Class V.)

Several of the French models and drawings, and almost all the remaining English works, may be referred to the sub-division of this section which treats of railroads. The material for the construction of common roads has already been noticed under the general head of materials. There are no drawings of special systems of road making, and the only apparatus for sweeping and cleaning roads and streets is that of Mr. Whitworth, which is well known in this country, and of which he exhibits a small working model. Under the head of finger-posts may be mentioned some very good labels for the names of streets, which are exhibited by Madame Hachette, Faubourg St. Denis, the material of which they are made is called enamelled lava; the names

Street labels.

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are very plain and clear, and the labels are similar in appearance to those used in Paris, viz., with white letters on a ground of a clear bright blue, and which are much better looking and more legible than any in use in London.

Street railways.

As the subject of more rapid communication between the remote parts of London and other large towns in this country is at present to a considerable extent occupying the attention of engineers and the public generally, it may not be out of place to introduce in this place a short account of a street railway which, though not actually represented in the Exhibition, was yet in such close proximity to one of the buildings, viz., the "Annexe," as to afford every opportunity of not only fully examining into its construction, but also of judging of its general working under different circumstances, as to weather, &c., and its effect upon the ordinary traffic of the road. The railroad in question reaches from the Place de la Concorde to Passy, one of the suburbs of Paris, a distance of more than a mile and a half, and is now being continued as far as the village of Boulogne, and is traversed by a large kind of omnibus holding 50 people each, more than half of whom are accommodated on the roof, to which access is gained by a small stair at each end. These are drawn at the rate of from eight to nine miles an hour by two horses, which can be hooked on to either end of the omnibus to avoid the necessity of turning. A detailed account of the method of construction of this and two similar railways in New York and in Nantes, with an estimate of the cost is given in a French work, called "L'Ingénieur," from which the following particulars are extracted, and to which I am indebted for much information concerning the French works in this class.

The railway consists of a single line of rails, with a short length of a double line at the extremities and in the centre, for the convenience of passing, the curves are in no case of less radius than 55 yards, and the gradients are in general less than 1 in 100, except where it crosses the approaches to bridges or paved crossings, in some of which cases the slopes are as steep as 7 or 8 in 100 for a short length of from 20 to 30 yards. The top of the rail is level with the surface of the road (which is macadamized), and has an indent or groove to receive the small flanges of the wheels of the omnibus.

The line is close to the edge of the footpath, partly on the right and partly on the left side of the road; the rails are spiked down to longitudinal wooden sleepers, which are notched into transverse sleepers buried in gravel or sand well rammed, at distances of 6 feet 6 inches. The rails are in lengths of 20 feet, and weigh 13·3 pounds to the foot; the

sleepers are about 6 feet long and 4 inches by 2 inches. The following is given as the cost of construction per yard run on a macadamized road.

Materials.

	s.	*d.*	£	*s.*	*d.*
Iron.—Two rails, weighing 80 pounds, spikes, and joint plates - -	11	9			
Wood.—Longitudinal timbers and sleepers and wedges - - -	4	0			
Gravel for making good road, at 7*d.* per foot cubic - - - -	0	10			
Total materials -			0	16	7

Labour.

Boring holes in sleepers - - -	0	7			
Framing, carpenters' work, &c. -	0	6			
Transport of materials - - -	0	2½			
Opening trenches, 1 foot 4 inches deep, for sleepers - - - -	0	11			
Taking away surplus excavation -	0	11½			
Fixing sleepers and rails, ramming, &c.	1	1			
Total labour -			0	4	3
Taking up and making good pavements, curbs, extra work in curves, points, reduced to the yard run -			0	0	10
Total per yard run - - -			£1	1	8

A street railway has lately been constructed at Nantes by the Orleans Railway Company, to connect their terminus with the quays, of which the following particulars are given. This line of railway is nearly two miles in length; it follows the line of quays, crosses the most crowded thoroughfare of the town and the approaches to three bridges, and is entirely open to the public, presenting no obstacle to foot passengers, and being open to carriage traffic for a great part of its length. The length of single line is 1,370 yards, and of double line exactly a mile, giving a total of 4,895 yards of line, of which 2,530 is on road used by foot passengers only, and 2,365 yards crossings of streets, &c. on the level, and on roads liable to be traversed by carriages. The rail employed is a bridge rail, weighing 18 pounds per foot, fixed by galvanized iron screws 3 inches long, to longitudinal timbers 10 inches

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wide by 4½ inches deep; the rails are connected together by transverse bars, weighing 17½ pounds each, having the ends turned up so as to fit into the hollow of the rail; two of these are used for each rail of 16 feet long, but experience has shown that half the number would have sufficed. The ends of the rails are joined and kept in the same line by a small dowel of compressed wood in the hollow of the rail. For the crossings of streets, &c., and where liable to be traversed by carriages, a flat iron bar, 9 pounds to the foot, is screwed in a vertical position to the inside of the timber. Without going into the details, the cost of this line may be stated as follows :—

	£	s.	d.
For a yard run of single line on road, where liable to foot traffic only, including paying all the woodwork, with three coats of marine glue -	0	16	6
And on crossings of streets, &c. for carriage traffic, per yard run - -	1	3	8

This system of street railway seems to have been first used in the streets of New York, and is now employed in several of the cities of the United States with good results. The American mode of construction differs but little from that first described; the curves are, however, very much sharper, coming down to a radius of 45 feet, for which latter cast-iron rails are employed, the outside rail being flat, and the inner one grooved for the reception of the flange of the wheel.

The subject just described forms a connecting link, as it were, between the two subdivisions of the 7th section; and in entering on the second part, or that devoted exclusively to railways, it will be remarked that by far the greater number of the articles enumerated are referred to, and have been treated of in another class (Class V.—Transport); this will account for the simple and economical turntable of Mr. Dunn of Manchester, the crossings and points of Mr. Carr and Mr. Wild, and all the different forms of permanent way being passed over in this report.

Railway viaducts.

Under the head "railway viaducts," are included some of the most important works in the Exhibition, both from France and England; and, beginning with those from the former country, we have a model, accompanied by a water-colour drawing, giving a general view of the bridge or viaduct of Tarascon, which carries the railway from Marseilles to Avignon (Chemin de fer du Midi) across the Rhone.

Viaduct of Tarascon.

between the towns of Tarascon and Beaucaire, and which was built by M. Talabot. It consists of seven segmental arches, of equal span, of cast iron, springing from masonry piers. The piers are 70 feet by 30 feet, with an average height of 80 feet; and their foundations are placed at from 25 feet to 35 feet below the level of low water, each on a mass of concrete, surrounded by a double row of piles, the space between the two rows being filled with regular blocks of cut stone of an average weight of 6 tons; a slope or bank of rough blocks on the outside of the second enclosure serves to protect the piles without much diminishing the waterway of the bridge. This mode of foundation was adopted to meet the difficulties arising from the nature of the bed of the river, being liable to be constantly worn away and undermined by floods, which undermining has sometimes taken place to a depth of as much as 45 feet. The piers are at distances of 224 feet from centre to centre, leaving a waterway of 198 feet between them; each pier is corbelled out 3 feet 6 inches at each side below the springing of the arch, so that the actual span of the arches is 204 feet 6 inches, and their versed sine is 16 feet 6 inches. The piers are terminated at each end by semicircular projections, which are continued up to the level of the parapet; and each pier is of sufficient solidity to stand the lateral thrust of the arches on one side of it, in the event of an arch failing. Each arch is composed of eight ribs of cast iron 5 feet 6 inches high, and having the extrados and intrados concentric. The distance between the ribs is 4 feet $1\frac{1}{2}$ inches, with the exception of the outside ones, which are 4 feet 6 inches from those next to them, thus giving a breadth of arch of 29 feet $7\frac{1}{2}$ inches from out to out. Each rib consists of 17 voussoirs, of an average thickness of 3 inches, strengthened at the top, bottom, and neutral axis by concentric or parallel flanges; they have also a flange 16 inches in width at each end, by which they are bolted together by wrought iron bolts 2 inches in diameter. The ribs rest upon the piers upon large plates or chairs of cast iron, fixed to the granite skewbacks, by which means the pressure of each arch is distributed over nearly 200 square feet, and double wedges are introduced into the joints for the purpose of tightening up the ribs to an equal pressure. Two sets of cross braces, or struts, at the line of the upper and lower flanges of the voussoirs, provide for the lateral stability of the ribs, and keep them at their proper distances apart; those at the upper rib are tightly wedged up against the voussoirs with iron wedges filled in with iron cement, those at the lower flange being very light, and so

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disposed as to leave each voussoir independent of the adjacent ones in the same rib. From the top of each rib spring a series of frames formed of vertical standards of cast iron, each strengthened by longitudinal flanges or feathers, and with braces in the form of a St. Andrew's cross between the uprights; these fill in the spandrils with as much rigidity as if they were solid, and being bolted together help to distribute the load more uniformly over the arch; they are kept in their places at the level of the extrados of the arch by coffers or frames of cast iron 7 inches deep, ½ inch thick, and with an average length of 2 feet 6 inches, arched to a height of 3½ inches, bolted together and resting upon the stanchions and frames of the spandrils, and over the crown of the arch on the voussoirs themselves On these is spread the ballast, with a mean thickness of 2 feet, reduced over the crown of the arch to 1 foot 6 inches, and enclosed at a distance of 2 feet 6 inches from each side by a brick dwarf wall, on the exterior side of which rises a cast-iron plinth and balustrade; the weight of each arch complete is 1,670 tons, and the permanent load on each is 967 tons. The materials employed in the construction of each pier were 84,000 cubic feet of concrete, 60,000 cubic feet of ashlar, 2,625 cubic feet of granite, 49,000 cubic feet of rubble masonry, and 8 tons of wrought iron. Taking the weight of the arch ballasted at 1,700 tons, and that of two trains of goods at 300 tons, it follows that the maximum pressure on the foundation is 10,224, or rather more than 4½ tons on each square foot of surface.

Pont Napoléon.

The next bridge or viaduct in the list, viz., that over the Seine at Bercy, a suburb of Paris, and called the "Pont Napoléon," is for the double purpose of road and railway, having been constructed to connect the "chemin de ceinture" with the terminus of the Orleans railway, and in addition, to give increased facility for the ordinary traffic between the two banks of the river. It is a stone bridge of five segmental arches, having each a span of 115 feet 6 inches, with a versed sine of 14 feet 9 inches, each arch is faced with 89 voussoirs 4 feet high, the rest of the arches being turned in very small rough rubble masonry set in cement, and the spandrils built with the same material, the body of the arch being 4 feet in thickness throughout. The spandrils are carried up internally to the level of the extrados of the arches by seven small parallel longitudinal vaults which are covered with cement and asphalte. The foundations are on timber gratings and concrete, and the entire bridge was opened to the public in nine months from the time of its commencement,

exclusive of the time when the works were interrupted by the height of the river. The great peculiarity in this system of construction is the substitution of small rough stone and cement for ashlar work, thus trusting almost entirely to the cement; the rapidity with which such a structure can be carried out seems greater than in the more common method of construction, but as the cost is not given, a material element is left out in comparing the merits of the two systems. The constructor of this bridge is M. Couche, ingénieur en chef des ponts et chaussées.

Pont d'Asniéres.

The next bridge we come to is also in the suburbs of Paris, and carries the St. Germain railway over the Seine at Asniéres; it is remarkable as being the first attempt to introduce the system of tubular wrought-iron girder bridges into France, and was designed by M. Flechat, engineer in chief of the St. Germain railway, and President of the French Society of Civil Engineers. The original bridge having been destroyed by fire in 1848, a temporary wooden bridge was immediately substituted, and the present bridge was afterwards constructed on the same site without a single day's interruption of the service of the railway. This bridge is composed of five bays, the two nearest the banks having a span of 102 feet 6 inches, and the remaining three of 108 feet; it consists of five parallel wrought-iron tubular girders, each 560 feet long, 7 feet 6 inches deep, and 3 feet 3 inches wide, except the two outside ones, which are only 2 feet 7 inches wide, the plates composing the sides of these tubes are 27 feet long, 2 feet 3 inches wide, and $\frac{1}{4}$ inch thick; those of the top and bottom are 20 feet long, 3 feet 3 inches wide, and with a maximum thickness of half an inch. The tubes are kept in their places laterally by means of transverse wrought-iron rectangular frames, and diagonal braces or St. Andrew's crosses, which are placed alternately between the tubes throughout the whole length of the bridge, and the upper sides of these transverse frames serve to support the rails, of which there are four separate lines, one in each interval between the tubes and on a level with their upper sides. At the parts of the tubular girders at which they rest on the piers and abutments, a cast-iron plate is bolted on to the under sides of the tube, which slides on a grooved cast-iron chair secured to the stone work, and kept profusely lubricated with oil.

The tubes are simple rectangles in section, without any cellular chambers at top or bottom, and the iron of which the top and bottom plates is composed varies in thickness throughout their length, the amount of variation having been determined by considering each tube as a continuous

girder supported at six points, and sustaining a load whose position in relation to the points of support is constantly varying; the breaking weight was then calculated for each position of the load, and a curve was constructed representing the different values so obtained, and from this curve the thickness of the plates was determined.

One of the conditions imposed on the engineers in constructing this bridge was, that the traffic of the railway (being as great as six or seven trains an hour) should not be interrupted, and as the new bridge was to be built on the site of the temporary wooden one, this was a matter of no small difficulty, and not the least interesting part of the history of its construction is the description of the method in which this was effected.

The wooden bridge consisted of four ribs supporting three lines of railway, and in constructing the iron one to carry four lines a fifth girder was introduced, so that three of the iron girders should go in the spaces between the wooden ribs, and the remaining two, outside of the two extreme ribs. These two latter girders then could evidently be placed in their position without in any way interfering with the temporary bridge. In order to introduce the other tubular girders between the wooden ribs, it was necessary partly to cut away the cross bracings by which these were connected, and which consisted of diagonal braces or St. Andrew's crosses laid horizontally at the upper and lower sides of the ribs, and of a third series placed vertically at intervals. The iron girders, being considerably less in depth than the wooden ribs, permitted the former to be placed without being obliged to disturb the roadway or upper set of braces above mentioned; the lower and vertical series of braces having been removed for a certain distance at a time, the iron girders were introduced from below between the wooden ribs, in lengths of about 50 feet, placed end to end, and riveted in their positions. The roadway of the temporary bridge was then supported from the iron girders by means of wedges, and the wooden ribs removed; nothing then remained to be done but to lower the lines of rails to their new level, viz., 4 feet below that which they held on the temporary structure, and to adjust them to the intervals between the tubular girders, the whole of which was accomplished in three operations, each operation being completed in less than a night.

The entire weight of ironwork in the bridge is about 1,000 tons, and the construction, exclusive of raising into place, was undertaken at 23*l.* 3*s.* 1*d.* per ton.

Viaduct of the Durance.

The viaduct of the Durance was constructed to carry the railway from Lyons to the Mediterranean over the river of that name, and is situated about 2½ miles from Avignon; it is entirely of masonry, and was constructed by the engineer of the Tarascon viaduct, M. Talebot. The principal difficulties to be overcome in its construction resulted from the extremely rapid nature of the river, and its liability to become violently flooded, and consequent to produce sudden changes in the form and position of its bed; at the site of the viaduct the inclination of the water is 25 in 100, and such is its increase by floods that its volume, which in a normal state is about 1,700 cubic feet per second, becomes at such times as much as 200,000 cubic feet per second, or nearly 120 times its original quantity. This rendered the greatest care necessary in the foundations, and they were accordingly formed in one continuous mass of masonry and concrete from one side of the river to the other, 5 feet thick and 66 feet wide, projecting 11 feet 6 inches beyond the piers at the upper side, and 25 feet 6 inches at the lower side of the bridge. Under twelve arches out of the twenty-one of which the viaduct is composed, viz., the six nearest each bank, the foundation is carried across as a flat surface 2 feet below the lowest water level, but under the remaining nine arches, inverted arches with a versed sine of 5 feet are formed, which are carried out to the extremities of the masonry. This foundation rests on the gravel of the bed of the river, which was dredged away to the necessary depth by a 15-horse power dredging machine; it is bounded above and below the bridge by walls 6 feet thick, and 8 feet and 5 feet respectively in height, and covered with flagging, between which the concrete was thrown, and afterwards paved on top with rubble intersected with bonding courses of ashlar. The viaduct, as stated above, consists of 21 arches, each of 72 feet 6 inches span, and with a rise of 22 feet; they are 5-centred, elliptical in form, and at each side of the bridge the springing of the arch is raised, so as to present in elevation a segmental arch of 6 feet 4 inches rise. The piers are 11 feet thick, and are of sufficient solidity to stand the lateral thrust in case of a rupture or failure of one arch; the abutments are pierced by arches through which the towing-path is carried. The total length of the bridge is 1,760 feet or a third of a mile; and the width of waterway 1,386 feet; the width is 28 feet extreme measurement, and 24 feet 9 inches between the parapets; and the height of the rails above the low water level is 31 feet 10 inches. The arches and piers are faced with ashlar, and filled in with rubble masonry; the centres

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of each arch were fixed and struck in one piece (the striking being performed by double wedges), from eight to ten days after the completion of each arch.

Viaduct of the Bouzane.

The viaduct of the Bouzane is on the railway from Châteauroux to Limoges, over the river of that name, and was constructed by M. Borel, engineer in chief. It consists of 16 semicircular arches of 52 feet span, the total length is 1,012 feet, with a breadth of 27 feet 4 inches, and an elevation above the low-water level of 124 feet 6 inches; the foundations were laid on the solid rock, of which the river's bed is composed, by means of cofferdams, the piers have a batter of $\frac{1}{20}$th of their height, and the cutwaters are carried up to the level of the parapet to form stations for the guards along the line; the arches are 9 feet 9 inches thick at the springing, and diminish to a thickness of 3 feet at the crown; the railway is carried on three longitudinal vaults, over which the ballast is 2 feet thick, and there are weepers or gargoyles in the spandrils to carry off the surface water. There were employed in the construction of this viaduct 110,000 cubic feet of masonry, and the total expenditure was 45,057*l*.

Britannia bridge.

Among the models of railway viaducts in the English section, the most important is that of the Britannia Bridge, a structure so well known in this country that any description of it would be quite superfluous. Mr. Brunel's great

Saltash bridge.

Saltash Bridge, now in process of construction, and which has been already alluded to under the head of foundations, may be said to come next, as the span of its two largest openings approaches within a few feet of those of the Britannia; in principle it is a sort of combination of the arch, tubular girder, and suspension systems, the roadway being suspended from a wrought-iron tube of an elliptical section, forming a segmental arch with a rise of about a fourteenth of its span, and the horizontal thrust of which is counteracted by having its ends connected by a chain, which is also attached to the vertical rods by which the roadway is suspended from the tube, as well as to the roadway itself. The trapezoidal spaces formed by each two verticals, the tube and the chain, are braced diagonally, as are also each pair of verticals themselves. The two centre bays which are thus constructed have each a span of 458 feet, the height of the road above the water being 100 feet, and they are connected with the banks by two viaducts of ten and seven bays respectively, formed of iron girders resting on masonry piers, and the total length from shore to shore is 2,200 feet.

Chepstow bridge.

The Chepstow viaduct on the same principle, also by Mr. Brunel, was exhibited and described in the Exhibition of 1851.

A tubular girder bridge, erected on the Manchester, Sheffield, and Lincolnshire railway at Gainsborough, by Mr. Fowler, is the only remaining specimen of an iron viaduct in the English collection. It crosses the Trent at an angle of 50°, and has two spans of 180 feet; it is carried by two tubular girders, which form, as it were, the parapets of the bridge, and which are further strengthened by having a wrought-iron arc or rib inserted in each tube; the tubes rest on a masonry pier in the centre, and are connected with the bank at each side by an arch in masonry.

Gainsborough bridge.

Two wooden railway bridges are sent, one by Captain Moorsom over the Nore in Ireland, on the American lattice principle, and the other by Mr. Brunlees, to show a method of removing a portion of the bridge for the purposes of navigation, in which the moveable part of the bridge is made to run back by rack and pinion work, similarly to the mangle or rolling drawbridge in use in fortifications, the only difference being that this runs back above the roadway, while in that of Mr. Brunlees the end is lowered by a screw to a sufficient depth to permit it to pass underneath the standing part of the bridge.

Captain Moorsom's lattice bridge.

The only other model of a railway bridge is in the Canadian collection, viz., that of the Great Victoria Bridge across the St. Lawrence at Montreal, and which, although occupying a space of some 30 to 35 feet in length, is still on so small a scale that little of the detail of the work is represented, and it is to be regretted that it was not accompanied by a model of a portion of the bridge on a larger scale, from which the methods of joining the tubes together, supporting them on the piers, and other matters of detail might have been gathered. The Victoria Bridge is by Mr. Stephenson, and is on his tubular girder or Britannia principle; the length of the tubular part is 6,138 feet, the length of the masonry abutments is 484 feet, and the embankments at both sides give an additional 2,366 feet, thus making the entire length of the work across the St. Lawrence 8,988 feet. The tubular part, or bridge, properly so called, consists of 25 bays, the centre having a span of 330 feet, and those at the sides 242 feet; the height of the tube above the water is 60 feet in the centre, and 36 feet at the abutments; the tubes, instead of passing through the piers as in the Britannia Bridge, rest on the top of them and abut together end to end, so that the side elevation of the bridge will present one unbroken tube of nearly a mile and a quarter in length, the ends being received in a tunnel of masonry in each abutment. The weight of the iron used in the construction will amount to 10,500 tons, all of which will be transported from Eng-

Victoria bridge, Montreal.

Capt. Fowke on Civil Construction.

land, and the masonry will be not far short of 3,000,000 cubic feet.

Railway stations.

Drawings of several of the most recently constructed railway stations in France are shown along with the models already described, from the Ecole des Ponts et Chaussées, but are more remarkable as architectural drawings, of which they are beautiful examples, than for any apparent novelty in design or detail. They consist of plans of the Paris and of the Lyons stations on the Paris and Lyons railway, bird's-eye view, section, and three elevations of the Bordeaux terminus, and similar drawings of the terminus of the Orleans railway at Nantes. These constitute the only representations of the class of railway buildings; and of the remaining articles enumerated in the classification as appertaining to railway construction, all are either unrepresented in the Exhibition, or, as already stated, have been referred to another class; this remark applies to the objects contained in the following list, which closes the 7th section of this class:—

Termini and stations, engine and carriage sheds, stores, and loading and discharging places.
Reservoirs of water, hydraulic cranes.
Accessories, crossing roads on the level, guard-houses, enclosure, gates, &c.
Moveables, safety apparatus, turning discs, and signals of all kinds.

The next section, No. 8, is devoted exclusively to the subject of bridges, which are classified as follows:—

Bridges.

Section 8.

Bridges in masonry.
Bridges in wood and metal.
Suspension bridges.
Turning, floating, and temporary bridges.
Bridges of boats.

The greater number of the bridges of which models or designs were exhibited have already been dealt with as coming under the head of viaducts on railways, and as such belonging to 7th section; and this applies more particularly to England, where comparatively few bridges of importance have of late years been constructed, with the exception of those connected with the different railways; and it is, probably, for this reason that a model of the Victoria Bridge over the Clyde at Glasgow, by Messrs. Walker and Burgess, and some projected bridges by Mr. Rennie, are the only models of masonry bridges contributed from this country.

From France there are a photographic drawing of the Pont de l'Alma, situated close to the machinery building, and which was almost entirely constructed during the period of the Exhibition, and of which the principle of construction was similar to that already described in speaking of the Pont Napoléon at Bercy, namely, the use of small rubble work, set in cement, for the entire work, with the exception of the piers and facing, which are of ashlar; the piers of this bridge are founded on concrete and masonry, laid by means of caissons, and such was the rapidity with which the rubble work of the arches and spandrills was executed, that, as it is stated on the drawings, but three-and-twenty days elapsed from the time of commencing the springing of the arches until the opening of the bridge to the public; it must, however, be borne in mind that this opening for traffic took place before the ashlar facing was applied (this not having been carried up simultaneously with the rubble), before the centres were struck, the foot-paths paved, or the parapets commenced, all of which were unfinished at the close of the Exhibition, in part owing to the failure of the foundation of one of the piers, which necessitated the removal of part of the superstructure for its relief. One of the most interesting points in connexion with the construction of this bridge is the method employed for striking the centres by means of cylinders filled with sand; the employment of this method does not produce the slightest change in the construction of the centering itself, as the cylinder is simply substituted for the wedges on which the centres are supported. The apparatus consists of a cylinder of wrought iron, 12 inches in diameter and 12 inches high, which is placed in a vertical position on a wooden platform, on which it is prevented from slipping by a circular piece of wood, $\frac{3}{4}$ inch thick, nailed to the platform, and fitting the interior diameter of the cylinder. Near the base of the cylinder, at four equi-distant points of its circumference, are bored holes an inch in diameter, which are stopped by corks introduced from the interior of the cylinder, which is then filled to within 2 inches of the top with sand previously dried and passed through a fine sieve; and into the space thus left is fitted a solid piston or plunger of wood, coinciding exactly with the interior diameter of the cylinder, and about 10 inches high; the whole apparatus, which is thus about 20 inches in height, is then introduced under the centres in lieu of wedges; and M. Bouziat, by whom this method has been invented and applied, gives the following account of the process of striking the centres:—

Pont de l'Alma.

Striking the centres by means of sand.

"In striking centres, at a given signal, the corks closing

Capt. Fowke on Civil Construction.

"the orifices in the cylinders are withdrawn by an iron "rod a foot long and ·31 of an inch in diameter, pointed "at one of its extremities, and flattened and turned up "at the other; the sand then issues slowly until it has "formed a little cone opposite each hole, and stops. When "everything is ready, the engineer gives the order to lower "from $1\frac{1}{2}$ to 2 inches; then, by means of the iron rods, "the men remove the cones of sand, and help its escape "with the curved end in the event of its having got wet "during the process of the work, until the piston shall "have descended the distance required, which will be noted "by a scale attached to each piston. The workman then "allows the little cone of sand to accumulate, and waits a "fresh signal, and in this way the centre descends gradually, "and detaches itself uniformly from the arch without "shaking it. It will be seen that, being completely master "of the operation, leisure is given to make all necessary "observations, so as to be assured that all goes on well, or to "take measures should the contrary be the case. At the "Pont d'Austerlitz, commenced the 20th May 1854, and "opened for traffic on the 8th November, the centres were "struck in two hours, and it might have been performed in "still less time by placing a man to each of the cylinders, "so as to lower all the centres simultaneously. Each "arch of the bridge was supported by 36 principals, and "the enormous weight of both the masonry of the arch "and the metal of the roadway bore on the centres, they "not having been removed until after the opening of the "bridge to the public."

Bridge of Dinan.

One of the most important of the French masonry bridges in the Exhibition is that of Dinan, by M. Fessard of the "Ingénieurs des Ponts et Chaussées," which was constructed for the purpose of carrying the high road across the valley of the Rance, which it crosses at an elevation of 132 feet above the level of the tow-path. The bridge, which is entirely of stone, is 660 feet in length; and its extreme height, including foundations, is 165 feet, and that of the abutments at each end, 82 feet; it consists of ten semi-circular arches, each of 52 feet span, and supported by piers 15 feet thick. The width of the bridge between the parapets is 23 feet, containing a roadway of 16 feet 6 inches, and two footpaths of 3 feet 3 inches each; the parapets are one foot thick, and 3 feet 3 inches high. The piers are founded on the solid rock, the foundation being put in in ashlar work in hydraulic mortar, which was also used in turning the arches, the rest of the work being in common mortar; the piers are entirely of cut stone, the interior of the spandrills and abutments alone being filled in with

rubble. The roadway is supported by two parallel semicircular vaults running the entire length of the bridge above the extrados of the arches, separated by a wall 3 feet thick, and having each a span of 4 feet 6 inches; they are in granite rubble set in hydraulic mortar. There have been used in the construction of this bridge more than 57,000 cubic feet of masonry, and 26,000 cubic feet of wood; and the total expense was 42,150*l.* CAPT. FOWKE ON CIVIL CONSTRUCTION.

The bridge of Pontiffroy, at Metz, is exhibited in model for the purpose of showing, not its construction, as that dates as far back as the 14th century, but as an example of a very successful restoration and enlargement, which has been carried out on the original bridge by M. Lejoindu, in which the whole bridge has been widened 10 feet, and the old work entirely covered with concrete, at an expense of 3,400*l.*, or 6*l.* 1*s.* per foot run. Bridge of Pontiffroy.

The widening has been accomplished in three different ways; first, by the construction of a set of stone ribs on each side of the bridge outside the original arches, and springing from the old piers, which are carried up 6 feet above their original height, so as to throw the new part of the arch into a flat segment instead of being semicircular, as is the case with the old ones, and thus reduce the weight of masonry in the spandrills; secondly, by carrying out a corbelled cornice beyond the face of the masonry; and thirdly, by the substitution of iron railings for the stone parapets.

The new ribs above mentioned are merely tied to the original work by three iron cramps in each arch, one over the crown and the other two at the haunches. The total length of the bridge is 560 feet, the waterway of its 11 arches is 415 feet, and its total width, as increased, is 35 feet. The period occupied in the work was ten months, during which time the bridge was never closed for foot-passengers, and only for two months (namely, during the laying of the concrete) for carriage traffic.

In the class of bridges constructed wholly or in part of wood, specimens are shown by England, Canada, Austria, and France; of the two in the English collection, one by Captain Moorsom has already been mentioned, in the last section, as being for the purpose of carrying a railway. A model of a project for a wooden bridge is sent by Mr. Rose, of Leith, which exhibits a very ingenious method of framing short timber into the form of an arch; the bridge consists of a number of wooden ribs or principals side by side, each rib being formed of baulks placed end to end in the position of the sides of a polygon, the alternate ribs breaking joint with each other, so that the angles of the polygon in each case are over the centre of the sides adjacent to them; the Wooden ridges. Mr. Rose's model.

Capt. Fowke on Civil Construction.

ribs are connected together by transverse pieces of timber, which are laid across the centre of the timbers of one set of ribs, and pass under the salient angles of the alternate ones; the roadway is supported from the arch by upright timbers with diagonals between them. The model of a wooden

Canadian bridge.

bridge exhibited by Canada is a project for a bridge with a span of 300 feet, it is supported by two girders, one an each side of the roadway, which is 22 feet wide; each girder is 28 feet high, and consists of an upper and lower sill, each of five thicknesses of timber bolted together side by side, the upper and lower sills being connected together by two rows of upright wooden stanchions and diagonal tie-rods in wrought iron, those diagonals on which the compressive strata falls are doubled in each bay, and in the two bays at each side nearest the abutments are replaced by wood, the ends of the stanchions rest in cast-iron chairs or shoes. The girder thus formed is further strengthened by a strong wooden arc or rib springing from the abutment 10 feet below the lower sill, passing between the timbers of the sill and between the double row of stanchions and diagonal braces, and rising at its crown as far as the under side of the top sill, to which it is attached by bolts and nuts as well as to the lower sill, and to all the stanchions which are crossed by it. A bridge exactly similar in every respect has been executed at Rock Island, near Stanstead, in Canada, but with a span of 150 feet only, for, as is stated, a sum of 750*l.*

Austria.

From Austria we have a model of a wooden bridge by a Venetian engineer, in which the roadway is supported by wooden ribs, each composed of two concentric arcs connected by vertical or rather radial pieces and St. Andrew's crosses, but it is not stated whether the model is merely an unexecuted project, or if it represents a bridge that has actually been constructed.

Iron bridges.

Under the head of bridges in metal, England is represented by one model only, viz., that of the cast-iron

Mr. Leather.

bridge at Leeds, by Mr. Leather, constructed in 1842, which consists of a single segmental arch of 120 feet span and 12 feet rise, composed of 10 ribs, and having the spandrills filled in with a series of St. Andrew's crosses; the mouldings and architectural details being somewhat Gothic or mediæval in character. The width of the roadway is 30 feet, and the total width of the bridge is 42 feet.

Belgium.

A small foot-bridge is exhibited, full size, by Belgium, in which the roadway (wooden) is supported on two light ribs of **T**-iron, which are connected together, and to a third rib, running under the centre of the bridge at a depth of 3 feet,

by wrought-iron ties; the span is 50 feet, and the width 2 feet 6 inches.

France.

Turning again to the French collection, we come to the Pont d'Arcole, of which a very large and beautiful detailed model is exhibited by the Ministre des Travaux Publics, is one of the most striking of the variously constructed Parisian bridges; it is by Messrs. Oudry and Cadiat, who are also the engineers of the great swing-bridge now being executed at Brest, and of which a model appears in one of the galleries of the "Annexe."

Pont d'Arcole.

The Pont d'Arcole has been built over one of the branches of the Seine, between the Island of the Cité and the main land, to replace a suspension bridge which formerly occupied the same site; it is constructed throughout of wrought-iron plates, and is particularly remarkable for the extreme lightness and thinness, even to apparent want of strength, of the centre or crown of the single arch of which it is composed.

The arch is segmental, with a span of 264 feet, and a versed sine of 20 feet 2 inches, and the entire width of the bridge between the parapets is 66 feet; the arch springs from two abutments of masonry, one of which is pierced for the reception of a towing-path. The arch consists of 12 wrought-iron ribs, placed at 4 feet 4 inches from centre to centre under the roadway, and 11 feet 6 inches under the footpath. These ribs are formed of a web ·47 of an inch in thickness, with flanges 1 foot 10 inches wide, riveted to them at top and bottom by means of angle iron ·39 of an inch thick; they are further strengthened by a certain number of vertical ribs of **T**-iron riveted to the web, and extending from flange to flange. The depth of the rib at the springing is 4 feet 4 inches, which is reduced to 1 foot $1\frac{3}{4}$ inches at the crown; the ribs are strutted from one to another by straight and diagonal struts of wrought iron and plate, and the spandrils are composed of open work, also of wrought iron; the foundation for the roadway is formed by Barlow rails laid transversely across the ribs and upper part of the spandrils, which disposition tends in a great degree to strengthen and tie together all the ribs and other parts of the bridge, these rails are placed so close to each other as to form a bottom on which the ballast and metal of the road are deposited; the depth of the road is one foot at its centre and 9 inches at the footpaths, and the rise or gradient of the road from either shore is only 1·6 in 100.

The foundations of the abutments are on piles, and protected by an enclosure of sheet piling; the masonry is rubble in cement, and the dressings are of cut stone.

Capt. Fowke on Civil Construction.

The arch of the bridge contains 900 tons of iron, wrought and cast; and the cost of this part of the work was 37,200*l*. The remainder of the work, namely, the foundations, masonry of abutments, roadway, footpaths, &c., cost 8,800*l*., making a total of 46,000*l*.

The swing-bridge by the same engineers is now in course of construction at Brest, over the Penfeld, and consists of two swinging or turning portions, meeting together in the centre, and opening horizontally; these semi-arches spring from circular towers of cast iron, turning on friction rollers, and are prolonged beyond the towers to form a counterpoise to the semi arches. The span of the bridge between the piers or pivots is 343 feet; the height, from low water to the soffit of the arch, is 98 feet, and the springing 72 feet, the rise of the arch being 16 feet. The width between the parapets is 23 feet. It is stated that with two men to each pivot the bridge will be capable of being opened or shut in ten minutes.

9th Section.—Water and Gas Distribution.

Section 9.

Works necessary when water is taken from rivers.

Springs and wells, searching for and conducting.

Artesian wells, and systems of boring (except where referred to Class I.)

Elevating machines (except where referred to Class IV.)

Aqueducts and pipes, both as conduits and for distribution.

Sluices, outlets, valves, cocks, fire-plugs, &c.

Fountains.

Establishment of large filtering apparatus.

Construction and arrangement of gutters, sewers, and cesspits; plans for the removal of soil (except where referred to Class XII.)

Laying and fixing of gas pipes, detailed plans of the distribution of gas in towns, syphons, &c. (except where referred to Class IX.)

Ganges canal.

The only representation of the first subdivision of this section is the model of the head works of the Great Ganges Irrigation Canal, which is sent from the Thomason College at Roorkee in the north provinces, but which is unfortunately not accompanied by any detailed models or description from which any information concerning its construction might have been gathered. The second and third subdivisions have already been mentioned in another place, and the fourth is referred to the classes treating of machinery. Conduit pipes were exhibited by several French manufacturers, among whom may be mentioned M. Paris, who

M. Paris's pipes.

sends iron pipes coated inside and out with a kind of enamel or glaze, M. Petit, M. Hermann, and M. Chameroy. In the pipes exhibited by M. Petit, which are of cast-iron, the only peculiarity consists in the joint, which is a kind of faucet and pigot joint kept tight by a ring of vulcanized india-rubber, being introduced between the end of one length and a shoulder formed to receive it in the end of the adjoining one. The lengths are kept close by two lugs cast on the end of each pipe, which are keyed to two corresponding lugs on the end of the next one. The operation is thus performed: the length to be laid is first keyed at the upper lug, and then held upright or at right angles to that already in position while the india-rubber ring is introduced, when, being brought down to its proper place, its own weight serves to compress the india-rubber, and it is then keyed at the under side, the entire operation for each joint occupying only about two minutes. These pipes were laid down in the machinery part of the building to convey the steam from the boilers to the various engines which drove the machinery, and however serviceable they may be as water pipes, they are certainly not adapted for the conveyance of steam, in which respect they failed miserably, and were ultimately replaced by a copper pipe with flange joints fastened together with bolts and nuts.

M. Petit's system.

The pipes exhibited by M. Chameroy consist of a cylinder of thin sheet iron, covered inside and out with asphalte; that on the exterior being mixed with sand. The different lengths are joined by a spigot and faucet joint, and in some of the examples by being screwed together. This description of pipe is said to have been used to a considerable extent in and about Paris; it has the advantage of being cheaper than those made of cast-iron, but its durability and capability to resist any great amount of pressure seem at the least doubtful.

M. Chameroy's system.

Some pipes, in which the cylinder of sheet-iron is covered on the outside with a thick coating of hydraulic cement, are shown by Messrs. Genot and Co., which would, perhaps, be still more economical than those of M. Chamercy, but it is not stated that they have been brought into actual use, nor are any particulars given either as to their price, mode of manufacture, or of joining the pipes together.

Messrs. Genot.

In the joint proposed and exhibited by M. Hermann, a hollow ring of pewter of triangular section is inserted between the ends of the pipes, which are made slightly bell-mouthed to receive it, and which, on being nutted up close, press on the ring with a wedge-like action, and thus give a means of exerting a powerful pressure on the joint, the ring acting as a kind of caulking between the pipes.

M. Hermann's system.

Capt. Fowke on Civil Construction.

M. Schweppé's system.

A sixth kind of pipe is exhibited by M. Schweppé, which is made of wood, covered both on the exterior and interior with a thick coating of pitch and tar, which, he contends, will have the power of preventing the wood from being acted upon by either the damp of the surrounding soil or by the water or other liquid conveyed in the pipe, and, consequently, of preserving it for a long time, or, as M. Schweppé himself says, of making it unalterable; which statement, however, does not appear to be borne out by any previous experience. These wooden pipes are made in lengths of 6 ft. 6 in., and of different diameters, the thickness of wood being in each case about one-third of the interior diameter of the pipe. They are put together with faucet joints, and are offered at extremely low prices, those of 1½-inch bore costing 1*s.* a yard, and those of 12 inch bore 9*s.* a yard, or if hooped with iron 1*s.* 3*d.* and 12*s.* respectively; and the fixing is said not to exceed 1½*d.* for the length of 6 feet 6 inches of the former, and 9*d.* of the latter dimension, this being, of course, exclusive of excavation. These wooden pipes are said to be stronger than those in asphalte by M. Chameroy, and some of those exhibited are stated to have borne a pressure of 75 lbs. on the inch without being hooped. The remaining items in this section, viz., sanitary measures and gas manufacture, being included among the objects referred to other classes, we pass to the concluding section of the classification.

Section 10.—Special Constructions.

Section 10.

Plans and models of public buildings necessary in great centres of population, such as markets, abattoirs, warehouse, public granaries, &c. (except where referred to Class XII.)

Plans and models of private houses, exhibited as specimens of improvement in the art of construction.

Plans and models of habitations destined more especially for the working classes, exhibited as examples of improvement in this branch of construction, whether as to convenience, salubrity, or economy (except where referred to Class XII.)

Plans and models of buildings and constructions of various kinds, exhibited as specimens of improvement in the construction of buildings devoted to industrial purposes, whether mineral, agricultural, or great manufactures, &c. (except where referred to the classes treating particularly of these several industries).

This important section of the 14th class has, strange to say, but few representatives in the Exhibition, and it is to be regretted that no plans or models of any of the public

buildings of this kind, of which Paris furnishes so many examples, should have been included in the admirable collection of models contributed by the Minister of Public Works.

A plan or model of the great central market which is now being erected in Paris, with its light sheds of cast iron, its underground stores, communicating by a subterranean railway with the Chemin de fer de Ceinture, and, by this means, with all the railways entering Paris, would have formed an interesting pendant to Mr. Bunning's model of the beautifully-arranged New Cattle Market at Islington; but this great work is only represented by a couple of cast-iron columns, and the arch between them, forming one bay of the construction, and exhibited merely as a specimen of iron casting. A large drawing, being an unaccepted design for the same building, is contributed by that most indefatigable of architects and draughtsmen Mr. Hector Horeau; and if the competitors for similar constructions had followed his example, we should, probably, have had a most interesting and instructive series of subjects. England sends but three models of public buildings, viz., two of Mr. Bunning's, of the Cattle Market, already referred to, and of the City Prison at Holloway, and one by Colonel Jebb, R.E., of the Model Prison at Pentonville, all of which are too well known in this country to require any description. Canada contributes a model of the new Court House at Montreal, which, judging from the model, must be a handsome building, and highly creditable to the colony. It is a rectangular pile of building, standing on a high rusticated basement. It has both fronts alike, each consisting of an Ionic hexa-style portico, connected by a recessal portion to slightly projecting wings, surmounted with pediments. The end fronts are ornamented with Doric pilasters, and furnished with a pediment at top. Several drawings of churches, villas, public buildings, &c., are also sent from Toronto and Hamilton in Upper Canada, and afford pleasing evidence of the advanced state of civil construction in that country.

Islington market.

Court-house Montreal.

From India we have several models of native markets, courts, &c.; none of them, however, exhibited with a view to showing the construction of the buildings, but rather as illustrations of native manners and customs, and consequently not coming within the bounds of Class XIV.; and from none of the other English colonies or foreign states do we find any contribution in this section deserving of notice.

From France there are models by M. Duvoir Leblanc, of Paris, of a pavilion of the Hospital Lariboisiere, of the

France.

Capt. Fowke on Civil Construction.

great hall of the Institute, and of the kitchens of the Palace of the Elysée Napoléon ; but as they are exhibited to illustrate a peculiar mode of warming and ventilating buildings, they have, no doubt, been already dealt with by Dr. Arnott in his report upon those subjects.

There are two French exhibitors of modern dwelling or lodging-houses for workmen, viz., M. Dumesnil and Messrs. Van Cauwelaert and Co., but in neither case do the models exhibited show any great departure from the ordinary type in this country.

Model dwelling-house.

A model dwelling-house is shown, full size, in the garden behind the Palais de l'Industrie, by M. G. Clark, in which a number of building contrivances and peculiarities of construction are introduced, but which have all been noticed separately in their several sections as materials, and of which any mention here would be merely a repetition.

Before finally taking leave of the subject of civil construction, it may not be out of place to notice a subject in connexion with this branch of science which is represented in several instances in the Paris Exhibition, and the importance of which, in this respect, seems beginning to be acknowledged on all hands. I allude to the employment of

Photography.

photography for the purpose of taking drawings of works and buildings, and more particularly with reference to the transmission to a distance of drawings showing the progress of a work in course of construction ; for this purpose it seems likely to be peculiarly useful, from the fact that it guarantees perfect truth, and admits of no possibility of misrepresentation ; this latter qualification is happily of but small importance in this country, but it may be valuable in many cases in the construction of works abroad, where the work may be performed by contractors of unknown character, and at a distance from the superintending engineer. As examples of such progress drawings of large works, may be cited those of Mr. Vignolle's great work, the suspension-bridge at Kief, in Russia, exhibited among the English photographic drawings, which is probably the first instance of the application of photography to such a purpose. Photographic drawings are also shown by the French of the new Pont de l'Alma, and of one of the new railway stations on the Bordeaux line.

I have the honour to be, &c.

Francis Fowke,

Captain Royal Engineers.

Report on the present State of Design applied to Manufactures, as shown in the Paris Universal Exhibition.—By Richard Redgrave, R.A.

To the Right Hon. the Lord Stanley of Alderley, President of the Lords of the Committee of Privy Council for Trade, &c. &c.

My Lord,

1. Having been honoured with your instructions to examine into the state of design, as evidenced in the various objects contributed by our own and other countries to the Paris Universal Exhibition, with a view to estimate any progress made since 1851, I have prepared the following Report which contains the result of a careful investigation of the subject.

Subject of the Report treated generally rather than individually.

2. In reporting on a question so extensive as that of design, ranging more or less over 14 out of the 27 industrial divisions of the Exhibition, it has been found necessary to treat the subject *generally*, introducing remarks on *individual* works only as illustrations of any particular points to be enforced. And as the real object in view in endeavouring to give a just estimate of the true position of our own manufactures is to point to the sources of progress and improvement, it has been found desirable to allude to some of the collateral causes that have influenced, and continue to influence the taste and skill of our foreign competitors, and of our own manufacturers and workmen.

Relation of Fine Art and Industrial Art.

3. Although the fine arts are not included in the subject of this Report, their exhibition, together with industrial objects, gives some opportunity to estimate their relation to manufactures, especially in those higher branches wherein fine art merges in decoration and ornament.

Preliminary Remarks.

Eras of change of style.

4. There are certain periods in the history of the world, or of individual nations, when some great public event, some discovery, or some cause which deeply affects the public mind, produces a corresponding change in art also. Such for instance, in civilised Europe, was the change produced by the discovery of printing, and the dissemination

MR. REDGRAVE ON DESIGN AS APPLIED TO MANUFACTURES.

by its means of the writings and thoughts of the ancients. These led to the study and contemplation of those fragments of antique art which had survived the injuries of time and barbarism, and through their study to re-constitute beauty as the prevailing principle of art; to the subversion of the religious sentiment which had, for many ages, been its leading and all-pervading idea.

5. Again, when from political changes art became gradually estranged from its Italian cradle to be fostered by the growing power of the French kings; and when the victories of the Fourteenth Louis had gained him the title of the Great Monarch, art also was led captive in his triumph. No longer satisfied with beauty, she decked herself to please him in "barbaric pomp and gold:" splendour and display became her ruling principles, and the style called after his name was formed.

6. As we approach still nearer our own era other changes, not so marked, but equally characteristic, might be noticed as influencing art through changes in the outer and surrounding world; all these changes are clearly discernible to us who look back upon them, we can even trace them to apparent causes; but rising gradually and imperceptibly in their own age, they were then not clearly noted as points of departure, or as sufficiently influencing the prevailing taste to form a new and distinctive style.

First encouragement of industrial art in France.

7. The decorative arts, attracted to France by Francis the First, were actively patronised and encouraged by the succeeding House of Bourbon. Colbert, the Minister of the great Louis, established as royal manufactories the tapestry and furniture works of the Gobelins, Beauvais, and Aubusson, in which were executed by the most skilled workmen, aided by the most scientific men of the age, the designs of the first artists of France. In the succeeding reign the porcelain works of Sèvres became also a royal establishment with the like appliances.

Establishment of Royal manufactories;

8. In these royal manufactories every effort was made to attain the highest degree of perfection, and the works were carried on with princely munificence, entirely irrespective of the cost of production. By Colbert also, schools for the instruction of the workmen in drawing and the elements of art were organized in some of the principal seats of French manufactures.

and art schools.

9. By these means France, and more especially Paris, became gradually looked up to for works of luxury. The products of her royal manufactories were spread abroad among the other nations of Europe, either by purchase, or by gifts to the various monarchs and princes, and the skilled

labours of French workmen gradually led the surrounding countries to recognize her as the school of the decorative arts, and the acknowledged arbitress of taste.

10. The Revolution, and the long wars that succeeded it, though repressing for a time the intercourse with France, did not deprive her of those institutions which had tended thus to advance her in the eyes of the nations, or of the continuous band of skilled workmen and cunning artificers who were sure to emanate from them, to carry still higher her pretensions to be the chief source of objects of luxury and taste.

First international Exhibition, 1851;

11. To the long wars which had divided this Island from the Continent, and in many respects the Continental nations from each other, succeeded an equally long peace, during which commerce increased, and the accumulating wealth of Europe became everywhere invested in those vast undertakings which facilitate the intercourse of nations; thus leading insensibly to the first of those gatherings which were to bring together in one place all that science, skilled labour, and the arts could produce, by which each country endeavours to supply the growing wants, and to tempt the increasing taste for luxury in its own and other lands.

12. It was under this natural tendency of the age, and arising out of it, that the first great gathering of the national industries took place in 1851: it not inappropriately took place in our own country, which had most diligently laboured in the improvement of the means of intercourse, and actively promoted the free communication of nations, by the construction of railroads and ships, and the removal of commercial restrictions.

followed by the French Universal Exhibition.

13. To this first Exhibition, France, our nearest neighbour, was, after ourselves, the greatest contributor, and especially so in those objects for which she had so long held a high reputation. The first gathering of the industries of the world has been speedily followed by a second in France itself.

It included fine art.

14. In this second Exhibition the fine arts were more fully associated with industry as an integral portion of the Exhibition than in 1851, and the artists of Europe who had been invited—painters, sculptors, and architects,—largely responded to the call. The entire of the arts thus formed a most judicious *addition*, and one which gave a marked character to the Paris Universal Exhibition, inasmuch as the reciprocal influence of the arts on manufacture could be carefully examined.

Dependance of industry on art.

15. Former periods of advance in the products of the artizan in any country have been always connected with

Mr. Redgrave on Design as applied to Manufactures.

progress in the fine arts, and there is reason to believe that taste and skill in manufactures are seldom attained by a country in which the fine arts are neglected or not properly cultivated or encouraged. Here then was afforded an opportunity on a grand scale to consider the two in their mutual relations; and to examine the assembled products of the manufacturer and the artizan together with those of the artists of the several countries, in order to test if the inspirations of the latter had indeed led the others to a higher degree of taste, excellence, and skilful manipulation.

Probable influence of these Exhibitions on the age.

16. It has been already noticed that great public events, and the changed characteristics of the age, result in marked epochs of art and industry; and it is not too much to believe that these great international exhibitions, arising out of and consequent on the scientific improvements of the age and of the means of intercourse, may conduce to some such important change in public taste. In these exhibitions the manufacturers of all countries are striving to compete, not so much in works of ordinary excellence, as in the production of such as shall outvie each other, and be considered markedly in advance of the taste and skill of the times, and the result of these competitive struggles must be an advance to real excellence or a retrograde movement towards decline, according as they are made on sound or on ill-understood principles. There would be little difficulty in showing that in former periods the introduction of one false principle in decorative art, diverging at first but slightly from the truth, has led gradually to the entire adoption of a false, vitiated, and meretricious style; and it is therefore most necessary that nothing should be taken upon trust, but that a searching investigation should be made at the present time, lest we are led astray by the grandeur of the display, the vast amount of skilled labour, and the gorgeousness of the materials used, to accept the false for the true, the meretricious for the excellent, or the gaudy for the magnificent.

Nature of the Report, and its difficulties.

17. It is such an examination that is the business of this Report, and it must be recollected at its commencement that having this object in view, the tendency must be to criticism rather than to unhesitating approbation. The blandishments of false and meretricious excellence, of skill misapplied, must not be allowed to hinder the condemnation of works, however rare the talent displayed on them, but rather the reverse, for mediocrity will rarely lead us astray; it is the sins of genius that lead the multitude to do evil, and in such cases the more the talent the greater the crime.

18. On entering upon such an examination it must be remembered that there are many difficulties in the way of

a just judgment. As has been remarked, such exhibitions, however much it may be desired, can hardly be looked upon as the normal state of the manufacture. Each manufacturer is striving his utmost to attain notice and reward, not so much, it is to be feared, by an effort after perfect taste in his goods, as by an endeavour to catch the consumers by startling novelty or meretricious decoration, leading, in most cases, to an extreme redundancy of ornament. The goods are like the gilded cakes in the booths of our country fairs, no longer for use, but to attract customers. Hence, no doubt, much of the extreme glitter of these exhibitions; yet even this is a marked appeal on the part of the manufacturer to what, in his estimation, is the general taste of those who would be likely to be his purchasers.

19. The meretricious effect of many works is also greatly increased by incongruity of arrangement, arising from the juxta-position of those for totally different uses, and by totally different manufacturers. Thus ecclesiastical furniture may be seen placed side by side with the luxurious elegancies for the lady's boudoir, or the gaudy fittings of a theatre, and that which should be severe and simple in its treatment contrasted with all the enrichments of gold and inlays.

20. Moreover, it is too often the case that a work being selected as the subject for exhibition, its uses are entirely neglected, and it is looked upon only as to its capability to display all the resources of the manufacturer, who lavishes upon it all the materials of his workshop and all the skill of his workmen. The same piece, irrespective of any suitability, is covered with marquetrie, buhl, and inlaying; gaudy with many-coloured woods and various veneers; enriched with manifold carvings, and enhanced with mountings of metal, gold, and ormolu, attracting the wonder of the ignorant, or of those who judge less by reason than by the eye.

National tastes arising out of national habits.

21. Moreover, in endeavouring to form a just estimate of the exhibition, the difference of national taste must not be overlooked. It will be universally allowed that the French as a people are more deeply imbued with the love of and desire for ornament than other nations of Europe, and that, as compared with this country, the general knowledge of the middle and lower classes of Paris is, in such matters, above that of the same rank in England.

22. For this there are many causes, arising from political circumstances, climate, mode of living, and a hundred other things wherein they differ from us islanders.

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23. Our insular position has for some centuries prevented the necessity of fortified places, and "our cities are inhabited as towns without walls;" they spread without limit, and each Englishman indulges his love of personal freedom by dwelling alone. His house, although far more roomy in the accommodation it affords the individual family that occupies it, is in itself small as compared with Parisian structures, and within it, as his home, the Englishman concentrates all the comforts necessary to the enjoyment of his life.

24. The Frenchman, on the contrary, confined by fortifications and shut in by barriers, has, in his large towns, and especially in Paris, from this very limitation of space, carried his buildings upwards, and in these lofty erections of several stories many families dwell under the same roof.

25. This permits, without great cost to the individual tenants, of a more decorative treatment of the general structure, of the approaches and the ensemble of the building. Each family also is satisfied with far less individual accommodation than in our own country, and is content to make much of a small space and a few apartments. The climate also permits of their enjoying life more abroad, and the habits of society call them forth to the café and the theatre for those comforts with which the Englishman surrounds himself at home. These places of general entertainment, intended for the pleasure of the many, are richly decorated, and each individual lives more or less in public, and in the enjoyment of public splendours.

In France public buildings and art collections are open to all.

26. The taste of successive monarchs, suiting itself to the genius of the people, has led to the erection of magnificent palaces in Paris and its environs, and the talent of the greatest artists of France has from time to time been engaged to decorate them. Rich in carvings, in costly marbles, in gilding and painting, in mirrors and arabesques, they contain also collections of the rarest pictures and the finest sculptures of the artists of all ages. These are at certain times open to the people, and on fêtes and holidays are crowded, as a matter of right, by all classes, from the *ouvrier* in his blouse to the shopkeeper, the merchant, and the man of fashion. At these times, almost without restriction, the crowd range at will through the palaces of the Louvre, the Luxembourg, St. Cloud, Versailles, and the Palais Royal, and the even more gorgeous residence of the Préfet of Paris, the Hôtel de Ville. The same spirit which has led to the decoration of these sumptuous civil buildings has been directed by the Church to beautify its edifices, and, in addition to those which it already possessed, the Imperial family has adorned Paris with three new churches of unusual

magnificence, whose external and internal enrichment has taxed the skill of the first artists of the age. The Madeleine, Nôtre Dame de Lorette, and St. Vincent de Paul are the glories of the modern city, and illustrate the union of high art and decoration.

And are a school for art-workmen and the public.

27. These great national works, the constant sight of which has stimulated the public taste for ornament and decorative enrichment, have been the school for a body of skilled artists and workmen capable of gratifying it, and we find that many of the theatres, the cafés, the restaurants, and even the shops of Paris, in the richness of their decoration and the splendour of their gilding, vie with the palaces, which they attempt to rival.

28. Living, as has been said, more abroad than the English, the café and the restaurant are the daily resort of all classes. Theatres of all kinds, and cafés where refreshment is combined with various amusements, abound in all quarters of Paris, and are rarely unfilled; while even the streets are crowded, not with a throng hurrying to or from the labours of the day, but gazing at the rich wares that stock the windows of the Boulevards and the Palais Royal where even the food he eats is most artistically displayed to the eyes of the Parisian: even when wet or unpleasant weather arises, which prevents the pleasure seekers of other cities, the numerous glass galleries and covered passages which unite Paris by an almost continuous chain of promenades, inaccessible to winter and foul weather, permit to the Parisian his accustomed lounge.

29. The public promenades, moreover, which the genius of the nation has decorated with many national monuments (such as triumphal arches, sculptured fountains and statues) are, from the small area of the city, within the easy reach of the inhabitants of every district, and from the clear atmosphere of the climate, unclogged with the humid smoke which hangs over our own, these monuments remain sharp and unchanged by time.

Effect of over-abundant ornament on the public taste.

30. But all this decoration constantly around the Parisian, imbuing him unconsciously with a knowledge of and taste for ornament, and insensibly forming his inclinations and educating his eye, has its defects as well as its advantages.

Accustomed to gaze on the splendour, the gorgeous enrichments of palaces, to sit weekly in their salons on velvet couches, not alone to enjoy the chastened art of the great works that adorn their walls, but to feast his eyes on the gilded blandishments of the chambers in which they are enshrined; accustomed to the glittering brilliancy of his café, adorned for his delectation, and as much his home as

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his nightly dormitory, he cannot be content in his own home with the simple furniture suitable to his rank. His small apartments are fitted up for show rather than for *comfort*, a word not in his language: everything must simulate his out-of-door experiences, and if he cannot afford realities he will obtain the appearance of them by gaudy finery and over-decoration. In his commodes, his armoire, his hangings, his couches, his pendules, and his candelabra, utility is overlooked in favour of display and ornamentation.

National taste not always correct taste.

31. Taste, therefore, which is in accordance with the habits, inclinations, and general disposition of any people, may be *national* without being *correct*. It is with nations as with individuals, of whom we hear it said that one has a vulgar taste, another a refined taste, one a mean taste, another a taste for the beautiful or the magnificent. Thus in referring to the ancients, all who have had any knowledge of ancient art or literature would at once say that the Greeks as a people had a taste for the refined and the beautiful; in literature, always entering into the most subtile definitions and the nicest distinctions, and in art, refining all they undertook with the most sensitive perception of what is perfect; never leaving a new creation until they had by continual effort arrived at the most beautiful form, proportion, and colour of which it was capable.

32. The Romans, who succeeded to their art, were of a different character: grandeur and massiveness were the leading characteristics of their taste. Larger in mind than the Greeks, there was at the same time a coarse strength in their nature; and a barbaric grandeur, to which Greek art never attained, was the corresponding result. This was shown in the vast extent of their public buildings, (such as the Baths of Titus and the Coliseum, compared with which the largest works of the Greeks would appear diminutive) in the coarse vigour and bold relief of their ornamention, and the spherical curves of their mouldings.

33. Thus we see, that while each nation had a taste, the taste of each was wholly different; and in examining French taste, which has so long dominated over the nations of Europe, it is most desirable thoroughly to search into its principles, that we may know when it is worthy of being admitted and followed, and when it is to be rejected and a higher, purer, and more simple taste sought after.

Character of French taste.

34. We have already shown that French art is accommodated to the mind of the French people, and reacts upon it; that it is up to their requirements, mental and sentimental, and certainly not beyond them. Whatever it might

have formerly done, it now ministers to the inclinations of the people, but does not lead them. The French are a pleasure-loving people, of a gay and lively disposition, with a sensuous indulgence in pleasurable enjoyments, a proper national vanity and a love of display. To this their whole industrial art ministers; and from all causes, natural and induced, the tendency of the national taste is evidently to glitter and over-ornamentation, to display and finery rather than to decorated usefulness. Our great poet remarked this genius of the French people, in words that are as descriptive of the meeting of the two nations in the Champs Elysées in 1855 as on the Field of the Cloth of Gold in his own time. Here more than even there it might be said,—

> "To-day the French,
> All *clinquant*, all in gold, like heathen gods,
> Shone down the English."—*Henry VIII. Act I., Scene* 1.

and for this reason, while it must be acknowledged that heretofore France has been the arbitress of European taste and fashion, it is at this juncture most desirable to test thoroughly the ground of her pretensions, and to beware lest unconsciously "the world is still deceived with ornament," and led astray by pretentious display, instead of advancing in the road to real excellence.

35. The first step in this direction will be to attempt to lay down some general principles of taste in decoration, deduced from those works which in all ages have been considered excellent. Without such principles for our guidance, the inquiry would descend into vague and unsatisfactory assertions, a course which has fostered the idea that taste has no settled laws, but is a mere matter of fashion or individual feeling, against which there is neither dispute nor appeal.

36. There was an attempt made in the Report on the Design of the Great Exhibition of 1851, to define some of the principles of decorative art. As these are believed to be generally correct, they will equally apply to the present Report, and may be referred to, as far as they go, in support of the opinions and decisions it contains; it has, however, been thought necessary to carry the general argument somewhat further in the present paper.

On the Source of Style.

On the principles of style in decorative art.

37. In attempting to define the principles which should govern decorative design, the first consideration must be given to those dominating influences, which pervading all the works of a period, subordinate them to what is called

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STYLE. These influences, as we have already seen, may, and indeed must be various, and generally arise out of circumstances which impress the universal mind of the age, or of some nation pre-eminently great in learning, rule, manufacture, commerce, or the arts.

38. Style, indeed, will be universal in proportion as the sentiment which inspires it is more or less widely prevalent, more or less akin to our common nature; and on this account those styles which have arisen out of the religious sentiment are generally co-extensive with the religion which produced them.

39. When these influences arise out of the purer and nobler qualities of man's nature, the style they produce will be noble also, and being constantly around us, contribute in no small degree to raise the tone of individual and national feeling. The influence of a mean style, founded upon the ignoble or sensual qualities, will in a like degree tend to degrade not only our taste but our moral intellect also.

40. Thus the governing influences of Greece, when her art was formed, were the worship of the Deity through his created forms and attributes of *beauty;* and a sentiment of purity and beauty became the characteristics of Greek art. In the latter days of this people, when the poetical religion gave way before the subtilty of her philosophers, the sense of the beautiful only remained, and the principle of her art, deprived of the zealous fire that even an imperfect religious sentiment inspires, became more sensual under the domination of abstract beauty only.

in Greek art:

41. When the Greeks were conquered by the Romans, and their artists transplanted to serve the conquerers, they brought with them their own dominant principle, sensuous beauty. This, however, alone, ill suited the spirit of their proud rulers. In the full career of universal conquest, pomp and splendour were their governing influences, and a new style was formed, wherein a degree of barbarous grandeur dominated over the element of beauty.

in that of Rome:

42. As the Romans, from being the conquerors, became the conquered, their art died out under the mean and contemptible desire to appear what they no longer were; having no influence sufficiently strong to inspire their artists, they became degraded imitators, and even broke down the mighty works of their fathers to build trophies to call after their own names. The all-pervading spirit which had been present in the growth of Roman art being gone, Europe was ready for the new influence, which, gradually working on society, was to pervade all the nations in various degrees with the spirit of Christianity, and to produce the new styles

called Romanesque and Gothic, wherein the sentiment of religion again largely prevailed.

43. And perhaps the very circumstance that religion was presented by means of art materially to the senses, rather than spiritually to the reason and intellect, increased the universality of the influence. Not only had the churches, but the houses and all the worldly goods of our fathers, the outward impress of these new styles, which appearing first in the erection and decoration of splendid temples devoted to the worship of the Deity, gradually gave to all things an ecclesiastical character also.

of mediæval art:

44. When, from the causes before glanced at, the renaissance of ancient art took place, it was impossible that any sentiment of religion, which, in its own age, it might have possessed, could be re-born with it; the beautiful only was sought in this revival;—beauty, however, more or less tainted with the sensuality and pride of the peoples from the study of whose remains the resurrection to new life had been attempted.

and of Renaissance art:

45. Revived without a thorough identity between the sentiment of the age, and the sentiment of the past which produced it, this style became at once subject to national modifications. In our own country it resulted in the Tudor, a style redundant yet mean, grotesque without ingenuity, and without any constructive truth or consistency. It bore the impress of a people willing to borrow their art at second-hand rather than to endeavour to cultivate it at home. Flemish, Italian, and French versions of the renaissance were mixed up in a strange medley with the Gothic of the preceding age, and it had a character arising out of its very errors and absurdities.

Its decline.

46. In France the renaissance was gradually modified by successive monarchs, until the revived love of beauty which had given it re-birth gave place to the sentiment of pride. It was modified to pander to the self-esteem of the monarchs and people of the age, and mere meretricious splendour resulted in that style which is called the style of Louis Quinze. "In all that this style differed from the true Renaissance, it differed merely as arising out of decoration, and from the love for mere magnificence and display, for which it was admirably adapted, being one of the most suitable style for gilding, and for brilliancy and sparkle in metal and or-molu work; showy and glittering beyond anything attainable in the simpler forms of the renaissance or of classic antiquity."

47. It must however be allowed to have sufficiently marked characteristics to rank as an acknowledged style; the last

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in order which decorative art has developed, and, togthere with the other instances gone over, tends to establish that one of the first elements of true style is an all pervading and over-ruling sentiment.

The primary elements of style constructive.

48. In considering the elements of *style*, it must be remembered, that style is not merely governed by decoration, as is too often supposed, but originates in construction, to which decoration is only subsidiary ; and all the great æras of style have been notedly æras of changed construction. The mound-like temples of Egypt, the horizontal constructions of Greece, the arched vaultings of Rome, the vertical aspirings of Gothic buildings, contain as marked elements of STYLE in their *bare walls*, as when, in their completed state, they are covered with the rich decorative treatments peculiar to them.

Five propositions on the elements of design.

49. These preliminary remarks being admitted, it will follow, first, that style implies some dominating influence reflecting the mind of the age in all its works, and therefore presumes a certain unity of character throughout.

Secondly, that the primary elements of style are constructive, and that the design of a work must have regard to construction, and consequently to proper use of materials, prior to the consideration of its ornamental decoration.

Thirdly, that as construction necessarily implies a purpose, *utility* must have the precedence of decoration.

Fourthly, as construction necessitates a proper consideration of materials, and as each material has its own mode of manipulation, and is wrought by separate and varied processes; design must be bad which applies indiscriminately the same constructive forms or ornamental treatments to materials differing in their nature and application.

Fifthly, that as the greater regulates the lesser, the building should determine the style, and all which it contains of furniture or decoration should conform to its characteristics; and thus there would be a proper uniformity of style throughout, and a subordination of all the inferior objects to one another and to the whole.

50. Many minor principles are contained under each of these several propositions. In the few words of discussion on each, necessary to connect them with our present subject, these will be noticed, and it is hoped that the preliminary argument will lead to a better understanding of the whole question of decorative design as illustrated in the works under review.

On the influences which produce style.

51. The subject of the first proposition—the prevailing influence characterizing works and thus producing style, has already been touched upon. When this influence is

neither strong nor general, characteristic indications of style will be slight and hardly noticeable, and the age be imitative rather than original: even the slight national character that is present in art labours being less observable by the people themselves than by others.

52. Thus although to Englishmen there appeared so little originality in the art applied to our own manufactures at Paris, as to incline us to regard them as devoid of any peculiar character, we were less at a loss to perceive a nationality in those produced in Germany, France, or Spain. It was some satisfaction, therefore, on various occasions to hear the same remark from Frenchmen and others on the manufactures of their own land, namely, that they could recognize national characteristics, and many indications of novelty and unity of style in British goods, these qualities being absent to them in their own; a subject which seemed most justly a cause of regret on their part. Our mutual remarks are therefore somewhat encouraging to each other, and we may hope that there are influences at work to raise us above the rank of mere imitators of the men of other lands and other times—and as imitators necessarily short-comers—and to impress the national character of our age and people on our art and our works.

Spread of art-knowledge in England.

53. The great effort that is now made towards a widespread development of art education in Great Britain—and this not alone for the upper and middle classes, but for all, even the poorest, must tell upon the rising generation. Once properly instructed, there is very little doubt that the plain good sense, the energy of will, and the dislike of mere display of our countrymen will result in works of much higher excellence in decorative art than has yet been attained in this country, while the artizan will add to his admitted manual dexterity and thorough workmanship, the knowledge and taste that will enable him to add beauty to excellence, and to carry out the labours which the advanced taste of the general public will demand at his hands.

Style must be influenced by scientific discoveries of the age;

54. It has been said above that we are rarely sensible of our own growth and progress, and thus it is most difficult to estimate whether any sentiment arising among us is sufficiently all-prevailing, persistent, and strong to produce a style. Such, however, may be the case notwithstanding. There seem to be many symptoms that the desired change is arising, and will arise out of or be very materially influenced by the great scientific improvements and discoveries of our times. Not however directly, but indirectly. Changed materials are altering the whole system of construction, and

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utility, in such works, is of necessity a paramount consideration; the iron road has opened up to the multitude the power of seeing and enjoying nature; the camera fixes her most fleeting images, and allows us to surround ourselves with evidences of the marvellous and infinite variety of her beauties; the art of nature-printing places the very accidents of growth and structure palpably before us. As the altered character of the materials, and the necessity of strictly considering utility in our scientific works, has improved our knowledge of structure and weaned us from mere precedents in constructive art; so the opportunity of seeing and enjoying nature, and of searching into the details of her beautiful variety, has led to such a love and delight in natural objects as may be productive of a new style in decorative art also. If these sources of novelty are rightly understood and directed, they point indeed to a most hopeful future.

and by the more frequent recurrence to nature.

55. If there was any perceptible advance towards novelty in design in the great Exhibition of 1851, it was the tendency to *naturalistic* treatments of ornament, pervading not only those fabrics wherein imitative renderings are easily adapted, but those manufactures also in which the primary consideration of structure and use required at least some modification in the application of Nature's details to manufactures—as, for instance, in furniture and metal-work. The want of this proper modification was much reprehended in the report on the design of that exhibition, and works of the same character are open to severe criticism in the present one. As an indication, however, of an increased love of nature, and recurrence to her as the true source of ornamental decoration, it may be hailed with satisfaction notwithstanding its errors; and our endeavours should be earnestly directed to avoid former faults, and teach the *right* mode of seeing and making use of nature. Not by the mere imitative rendering of flowers and foliage, which is a means of study, but not the end; the ornamentist must be a much deeper student, if he would found a new style; if he seeks out the mode of development of vegetable growth, he will find that regularity and symmetry are the normal laws, while all that is irregular is accidental and extraneous.

Correspondence between natural and ornamental laws.

56. This is in strict accordance with the principles of ornament in the best times. Indeed, as was shown in the former report (Report on Design, p. 1653), in this lies the true distinction between pictorial and ornamental art, and that which has been called disparagingly *naturalistic* ornament, arises from the ornamentist forgetting his own laws, and the absolute laws of natural growth, and taking to

mere pictorial imitation, which regards the accidents and disturbances of growth only.

57. These normal laws would instruct the ornamentist that nature is developed in strict geometrical and numerical rythm. Thus leaves are placed on the supporting stem either continuously opposite, or alternate, or numerically recurrent; and as are the leaves so are the future stems placed also. Again, varied quantity would be learnt from the study of nature; while it would be found that all vegetation is developed under a law of numbers, those numbers most largely prevailing whose correspondent geometric forms give greatest variety consistent with symmetry: thus three, corresponding with the triangle, is the law of inflorescence of all endogenous vegetation, whilst the flowers of exogens are developed numerically as five, corresponding with the pentagon, much more largely than as four the less varied root of the square; thus contributing to the greatest amount of symmetry consistent with variety.

58. Moreover, the ornamentist might learn something of restraint, and be warned against over-ornamentation, by seeing how nature restricts her true ornaments, the flowers, to the most salient and culminating points of plants, and sprinkles them sparingly, contrasted with the foliage. It is not in place here to allude to the colours of nature, because the endeavour is simply to prove that the principle of symmetrical arrangement, advocated as the true law of ornament, is to be deduced from the study of nature's laws of growth, and while referring to the hope that an increased acquaintance with nature may be operating to produce a style, to insist upon the necessity of a thorough examination, and not a mere superficial acquaintance with her works: we shall then find "the art itself is nature," and that as Shakespear tells us—

> "Nature is made better by no mean,
> But nature makes that mean; so o'er that art,
> Which you say adds to nature, is an art
> That nature makes."

Difference between pictorial and ornamental art.

59. There was ever a true sense of ornamental distribution, which extended even to pictorial art when applied decoratively to walls, in the early Italian works, the principle being derived from Byzantine sources; and this was not wholly neglected by artists so late as the time of Francia and Bartoloméo, as evidenced in their balanced and symmetrical compositions. When, however, pictorial art began to assert itself over the decorative, and to assume its own high place and office, then the ornamental principle succumbed to pictorial treatment, and the painted ornament, as well as

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much also of the ornamental sculpture of the early renaissance, became pictorial and unsymmetrical; this will at once be seen by anyone who examines the bas-reliefs, or even the fruit and foliage of the architrave of the Florentine gates by Ghiberti. Herein pictorial art reigns paramount: the frieze which surrounds the gates is an imitative rendering of nature, hardly disposed according to the law of geometrical distribution; even the bas-reliefs are pictorial not sculpturesque: many planes enter into their composition; so that it may be said that the painter rather than the sculptor—the artist certainly rather than the ornamentist—has composed them. The return to classic examples stayed the innovation for a time in sculpture of the cinquecento period; but it became more dominant than ever in the 17th century.

Law of symmetrical arrangement.

60. Yet from what has been said, it must be evident that the law of symmetrical arrangement, is not only in accordance with a deeper insight into nature's working, but moreover lends itself to the absolute necessities of many manufactures, especially in this age of machinery, and to the best means for the display of form and colour in all; while the naturalistic view not only is difficult of execution in many manufactures and fabrics, but is a mere surface view of nature also; only concerning itself with what is open to every one, and neglecting those hidden truths which lie at the root of the whole subject.

61. Much more intense must be that man's love of nature who studies her inmost secrets to apply them anew, to his who only looks at her to make false and exaggerated imitations of roses, poppies, and peonies, to sprawl them over carpets; and reverses even her simplest laws to stand brass candlesticks on the points of leaves, to cause gas to jet out of the corollas of flowers, or to cover with bushes of grape or ivy the fronts of cabinets or buffets. The one studies nature, the other caricatures her.

62. It is in this spirit of a loving study of nature, and at the same time appreciation of art, that the courses in our public schools of art are now arranged. Alternately with the study of ornament, the pupil has natural foliage, fruit, and flowers placed before him: he is taught to imitate natural objects carefully, then the laws of their growth and development; and finally, as a step to invention, how to arrange according to like geometrical laws and principles the unnumbered beautiful forms and varied colours with which nature supplies him.

63. Moreover, many able writers and earnest workmen in this country have of late years endeavoured to inculcate the true principles of decorative art, and of the application

of nature's forms to ornament; and a general sense of the truth of these principles begins to prevail. An advance is everywhere apparent, and was especially so in some of our works in France, which, though competing with the higher skill of the French workmen, and the daring vigour of French designers, contrasted most favourably, by their quiet good taste, with the more showy works of our clever rival.

64. The question of the direct imitation or conventional treatment of natural objects as the details of ornament, has been of late much discussed, and indeed requires the fullest consideration, if, as has been suggested, there is a likelihood that the electrotype and the camera are leading, through a deeper insight into nature, to novelty of style, while a recurrence to nature for new elements is enforced in our schools.

The necessity of a conventional treatment of natural objects as ornament,

65. It must be remembered that absolute imitation, difficult in fine art, is almost impossible in many manufactures, whether by hand or by the machine, and therefore imitation can be but a question of degree. "Take for instance the application of art more peculiarly to manufacture by machinery; say that of calico-printing. Here the precise imitation of natural objects is impossible, since relief is unattainable, although the appearance of relief may be given by light, shade, perspective, and colour. But is the mode or degree of imitation peculiar to the artist flower-painter that which is most suitable or conducive to the desired end? In the first place, the processes of production control the application of colour, which must be laid on in separate and unblended masses by means of machinery, and not by that curious and delicate instrument the human hand, while the several tints also must be applied by successive and distinct processes; so that it would seem scarcely possible that calico-printing could compete with the imitative means at the disposal of the flower-painter. Let us, however, allow that by improved mechanical and scientific aids the imitation of flowers, foliage, or other natural objects in light, shadow, growth, colour, and relief could be rendered as perfect by machinery as it is by a Van Huysam or David Seghers; still the art is to be applied to a specific use, and not to be examined as a picture is. The fabric on which the painting is to be impressed is partly transparent, and the forms are at once blurred and indistinct; the garment it is intended to be made into is to hang full and in folds; thus the light, shade, and the very forms of the object which has been imitated, are confused and hidden, and that *imitation* which the manufacturer had been at such pains to produce

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is entirely lost and destroyed. The garment moves with every motion of the wearer, and any examination of this rare art, as we are enabled to examine the painter's work, is, in the use of the material, as impossible as it is undesirable.

arising out of the difficulties of manufacture.

66. Printing again necessitates a constant repetition of the same details; and what would be said of the painter who, instead of a rare flower or group of flowers, offered for our admiration a dozen or a hundred of the same monotonous form, the same unvaried colour, the same tedious arrangement of imitation? if the painter's imitation is sought for by the calico-printer;—let at least each flower, each sprig, each group, be varied and different. But, no; such is not the end in view: it is not to imitate the painter, it is not to attempt to vie with nature, that is the true aim of the calico-printer; the legitimate art to be applied to such fabrics is at once seen to be simply to decorate or enrich the surface with agreeable forms and colours, and if for this purpose we use the beautiful forms and colours of natural objects, we must use them consistently with the true use and purpose of the material and the means at our command to produce the effect sought for. As the machinery by which the art is reproduced acts by a constant repetition, a geometrical distribution of forms is more or less a necessity which cannot be overcome. As the tints must be laid on separately and successively, and cannot be softened or blended, the simplest combination of tints and colours must be sought for rather than the more intricate; a circumstance also called for by the market offered for such goods.

67. If varied hues of colour are introduced, to be agreeable to the eye, colour must be distributed according to fixed laws of quantity and juxta-position; which is scarcely attainable by that mode of imitation which is called naturalistic, but which lends itself readily to that symmetrical and regular display of the plant which is called a conventional treatment, a treatment shown to be consistent with the natural laws of the growth of plants, as it is with that simple impression which flowers in their natural state of growth make on the casual observer."*

On the direct imitation of nature; how far proper to the painter,

68. It has been already said that direct imitation of nature pertains to fine art, but not to ornament other than as a means of study. Even in fine art, imitation, although the necessary language of the art, is impertinent and mean when it becomes the end sought, or as an eloquent writer

* Pamphlet on the Necessity of Principles in teaching Design.

has expressed it "so degrading a thing is deception even in the approach or appearance of it, that all painting which even reaches the mark of apparent realization is degraded in so doing" (Ruskin, Seven Lamps, p. 31). Thus we acknowledge at once the sublimity and grandeur of Rembrandt, the deep mysteries of his generalized imitation of nature's great truths, while we despise the mean littleness of his pupil Dow, who wasted the capabilities of his art in the deceptive treatment of the rind of an onion, the knitting of a stocking, or in producing fur hair by hair.

or sculptor.

69. The sculptor, moreover, does not seek deceptive imitation, but rather the normal form only; otherwise it would not be necessary to consider if the colouring of flesh or draperies was permissible to the statuary: it would, as being the nearest approach to deceptive imitation, be the highest effort of his art. Such, however, is not the case; and although the ignorant are in the habit of making imitative deception a ground of wonder, the more intelligent and educated have consented to place it very low in the scale of artistic qualification, and to agree with the assertion "that no art is noble which in any way depends on direct imitation for its effect on the mind."

How far practised by the ancients.

70. But if mere imitation is inconsistent with nobility in fine art, it is also as inconsistent with the principles as it is with the means at command in ornamental art, which seeks either symbolic expression, or the merely beautiful, or both in combination. Its forms and colours of beauty and richness must be derived from nature, but are not of necessity copies of her works. "Symbolic expression," as has been said, "appeals altogether to thoughts, and in noways trusts to realization." Thus the well-known wave scroll of the Greeks was not imitative: it truly *symbolized* the ever recurring waves of their inland sea, but at the same time was an abstract form of beauty also. This was indeed the case with all their ornament; they chose, no doubt, the most elegant forms from leaf and flower, but they cared not to keep the least actual resemblance to the type they copied. Their ornament was all abstractedly beautiful, the most elegant and refined curves being chosen and the most rigid symmetry observed; sometimes as simply recurrent as in the wave scroll; sometimes alternately recurrent, as in the anthemion and tulip form of the frieze of the Erectheum, but always rythmical.

71. The Egyptians, although deriving the details of their ornament more evidently from nature, still treated them strictly as ornament and arranged them; and, not to tire with instances, the Jews (to whom, if there ever was a

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true inspiration of genius, we are to believe such inspiration was given,) deriving their ornament from natural objects, were taught by divine command to arrange it symmetrically and in a continuous order, the robe of their Ephod being bordered with "a golden bell and a pomegranate, a golden bell and a pomegranate upon the hem of the robe round about."

72. These principles of symmetry—of conventional treatment—and geometrical arrangement were handed down to us from the nations of antiquity through the Byzantine ornamentists, and prevailed almost exclusively in Romanesque decoration, and largely, if less decidedly so, in Gothic. If such laws of arrangement were necessary when ornament was produced by handicraft labour, how much more so are they in our age of production by machinery In all ornament so produced, whether by printing, stamping, or weaving, some law of geometrical recurrence, both of form and colour, is enforced by the requisite *repeats*, and takes place, however we may strive to disguise it, at oft recurring intervals, and the question is whether we shall strive to ignore and hide it in efforts after *pictorial art*, or whether it is not more judicious to accept it as a law and make it subservient to our own purposes, in the extended use, now more than ever advocated, of nature's treasures.

On past styles most largely adopted in the works exhibited.

73. Before passing from this section of the report, wherein the prospects of a new style are discussed, it will be well to remark on those past styles which were most predominant in the Universal Exhibition. Old styles are, and perhaps ever will be imitated; and indeed the larger number of works in the Great Exhibition consisted of imitations; but the mere imitation of past works will not renew or give real vitality to an old style. In order to do so, the artist must enter into the spirit of the past age, and be imbued with the same feelings that then prevailed; and not only the artist, but the world for whom he labours. He must go with the spirit of the time, or be strong enough to lead it, and this can only be done by an earnest and convinced will. Indeed, it must be allowed that in general the age as much makes the artist as the artist the age. Even in reproductions of old styles, national character has much to do: thus in English works some sympathy with the Gothic was largely evident, while in France the styles reproduced were mostly the cinque-cento renaissance, and that of Louis XIV. and XVI.

74. It appears a curious anomaly, although, as has been shown really very consistent with the French character, that in this, a Catholic country, there is so little tendency

to return to the truly ecclesiastical styles. The direction of French taste is certainly not to the Gothic, far less so indeed than is the case in Protestant England. Even in those objects and utensils which are for the service of the Church, the Gothic is rarely used, the Romanesque perhaps more frequently, while there is a strong tendency to take renaissance types for these purposes, not only in chalices, flagons, monstrances, &c., but also in altar work. And yet the renaissance is essentially a sensuous style, and far more fitted for the banqueting than for the altar table.

75. But if the renaissance prevails even in church furniture and plate, in the furniture and fittings of mansions it is absolutely dominant. Of the many large pieces of furniture exhibited in the nave of the principal building and in the Rotonde of the Panorama, there were but three or four that were at all Gothic in character, and perhaps not above one of these that could be praised for any careful adherence to style or to constructive or decorative truth, while of the renaissance and Louis Quinze periods, there were dozens of costly specimens. The gaudy sumptuousness of these last are in harmony with French taste, while the earlier renaissance offers so many opportunities for the exercise of their highly cultivated and artistic skill in carving fruit, flowers, animals, and the human figure, as to have been largely chosen for the display of these powers.

76. The only works competing with these were of an extreme naturalistic character, of the school of Liennard, where a less ornamental, although far more imitative style of carving gave even a greater scope to the dexterity of the carver, if at the same time they were still more licentious in regard to purity of decorative design.

77. In metal-work, it is hardly too much to say that in bronze utensils, such as chandeliers, candelabra, lamps, pendules, fenders, &c., the Louis Quatorze and Quinze styles prevailed over all others. This is not to be wondered at, since, as has been before remarked, these styles are truly metallic styles as regards decoration. The ornament of this character shows, by its interchange of surface, all the varieties of burnish and mat, of tooling and chasing to the greatest perfection, and these qualities the French fully appreciate.

Some evidence of superiority in the works of last century over the present.

78. It is, however, impossible to allow that the same excellence prevails in the present day, as in the works of the last century. The metal-work of that period, as a short visit to Fontainbleau would witness, is of the most varied character, and serves as types for continual reproduction. In the tooling, chasing, and consummate knowledge of the capabilities of the metal, the works of

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that time are far superior to the works of the present day, whether we look to the solid and massive-curved metal foliage of Louis Quinze, or the more jewel-like treatments of later Gautier work. For instance, what work of this character in the present exhibition is at all equal to the metal ornaments of the two exquisitely finished pier tables formerly belonging to Marie Antoinette, and which are now in the bed chamber of that queen at Fontainbleau. The delicate perception and finesse shown by the artist in the varied treatments of leaf, stem, and flower render these works a species of bronze jewellery, leaving far behind the frosted uniformity, the level propriety of the metal work of the secrétaire by Eloy Dupont, and yet this was considered among the best of its kind in the present Exhibition, and although not very large, was priced at 15,000 francs. From which we may remark in passing that the metal-work of France is not progressing, since they reproduce old types, and do not equal their exemplars in execution.

79. In silver work for the table, the best works were of earlier renaissance style, the figure forming a prominent detail of the decoration, the modelling and chasing being of a high character, and the work often oxydized, showing a greater reliance on the art than on the mere value of metal; for this purpose the cinquecento renaissance is highly suitable, and is much more artistic and refined than the Louis Quinze style, which has been less used both in French and English works in the precious metals, than in 1851.

The True Elements of Style arise out of Construction.

Second proposition that the primary elements of style are constructive.

80. The second proposition states that the primary elements of *style* are constructive, and that the design of a work must have regard to construction, and consequently to the proper use of materials prior to the consideration of its ornamental decoration. That the primary elements of style are constructive will at once be seen when it is remembered that the constructive application of materials gives the broad distinction between the architecture of the ancient and the modern world.

Ancient system of construction.

81. The ancient races sought grandeur and sublimity by building temples formed of enormous masses of stone simply imposed on one another, which we still gaze at with wonder and surprise. It is true that the feeling inspired is of the earth, earthy, the building of necessity clings to earth: we think less of the gods that were honoured by these labours than of the men that wrought them; yet, looking upon the huge Cyclopean walls, the monolithic pillars,

and the enormous lintels of these mighty structures, we acknowledge that, if man is magnified rather than God, "there were giants on the earth in those days." Such is the horizontal system of construction.

Mediæval system.

82. Our Gothic fathers wrought in another spirit: in all their doings they were looking upwards; like the Israelites of old, each had his own offering, each as it were brought his gift to the altar, his stone to the building, and lifted it higher and higher towards the God of Heaven, to whom the sacrifice was made, and who alone was to be magnified by the work. Such is the vertical system of construction, differing alike in the sentiment that inspired it and in the mode of using the materials of construction, and consequently in all the elements of style.

83. It has already been said that "the primary consideration of construction is so necessary to pure design, that it may be taken as a rule that whenever style and ornament are found to be debased, it will be seen that constructive truth was first disregarded, and that those styles which are considered the purest, and the best periods of those styles, are just those wherein constructive utility has been rightly understood, and most fully attended to." (Report on Design, 1851.)

Beauties arising out of constructive truth,

84. Thus in the masterpieces of Gothic architecture, the necessities of construction produced much of the decoration; for instance, flying and other buttresses and pinnacles, constructively necessary to resist the thrusts of the inner groined work and roof, were by the skill of the Gothic architect rendered strikingly beautiful and ornamental features, materially ministering to character. In castellated architecture also, the battlements and machicolations, at first constructed for use, were made to contribute largely to enrichment.

by the renaissance architects.

85. On the contrary, the renaissance architect being in too many cases but the mere revivalist of ancient classic constructive details, to apply them to modern uses, was obliged to resort to continual constructive shams and falsities.

86. The introduction of the arch into construction by the Romans had tended, even in their age, to modify the ancient principle, and when classic architecture was revived at the æra of the renaissance, the men of those days, who had seen the Gothic temple in its glory, were tempted still more to endeavour to unite the horizontal with the perpendicular principle. The two thoughts, however, are essentially distinct, as are all the constructive details they lead to, and a mixed or composite system of architecture is not to be formed by taking the ranges of columns, the porticoes, and

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roof-formed pediments of classic architecture, and piling them one upon another, as a child raises higher and higher his house of cards. If such a mixed style is to be arrived at, it can only be by an entirely new departure, by some master mind starting from the constructive root, thence building up the necessary parts, and gradually decorating the construction as it arises.

Faults arising from false construction.

87. Half the gross faults of bad styles may fairly be traced to false construction, and the using constructive parts merely as decoration, and this whether in architecture or in ornament, which is ever dependent upon it. It was this that debased the Gothic in its last period; it was this that reversed the columns of the Tudor style, that broke through pedimental roofings, or placed them unnecessarily within one another; and finally it was the want of even constructive *probability* that led to the gross extravagance of the Rococo style, and in the characterless age which has just passed away crowded our streets with absurdities, and made our architecture a byeword and a reproach. Architecture became the mere bond slave of precedents—precedents followed perhaps in the letter but never in the spirit; and thus the mere imitator lorded it over the original thinker. If a church was to be designed, the last consideration of the architect was the arrangement of the general plan, the constructive utility, the comfort and convenience of the people who were to hear and pray, the modes and requirements of the worship that was to be therein celebrated; these were wholly overlooked in order to patch together some Grecian portico and gothic spire. Or, was a museum to be built, so that some classic structure, as an elevation, could be adopted, what care was there as to the contents that were to be arranged or displayed therein, the convenience for lighting them so as to be seen to the best advantage, the best arrangements for their being visited, the provision for future extensions, or the characteristic expression of the whole that was to arise out of all these considerations. How best to stint the various heights within to the diameters and proportions of some oft reproduced portico was the great question, thus the whole came out with the cold frigidity of a dead classicality, ill adapted to modern wants. From the same causes did not our theatres look like prisons as far as any outward character was observed, and our workhouses have the jaunty air of Cockney palaces?

And from fiscal and parliamentary regulations.

88. But if this were the case with our public buildings, can it be said that our private ones fared better. In our towns, the architect was so hedged in by fiscal regulations, and tied and bound by Acts of Parliament regulating the

form, the size, and the number of openings for light and air, the mode of structure, and the very scantling of his materials. So watched was he by district surveyors, and by all possible means prevented from any attempt at originality, by being required to build streets to pattern, with houses all alike within and without, that his imagination was spellbound, and the new quarters of our towns are in consequence as regular as, and far less striking than, a range of cotton mills. How different this from the vigorous licence of our forefathers, whose picturesque *barbarisms* and careless vigour yet surprise and delight us. What wonder that men who were to design houses to be erected by dozens to the same pattern became so chilled down to the same level of uninventive uniformity, that to fit a plan to some classic elevation from Greece or Rome was the utmost stretch of their inventive powers. Happily, however, these times have passed away, and a new race of architects have arisen with the new order of things.

Effect of bad architecture on furniture and decoration.

89. But while our architects were content to put columns that supported nothing, roofs that covered nothing, and parapets and balustrades that protected nothing; to put sham attics to hide the construction of ugly roofs, to make us peep through the scroll-work of a frieze, or the channels of a triglyph instead of a window, or to make the pedestal of a statue into a chimney pot, how was it likely to fare with furniture, which became a sort of toy architecture? Was it to be wondered at that all constructive shams were increased tenfold when used as ornament; was it surprising that Grecian stone altars formed our sideboards, Roman temples our cabinets, sarcophagi our sideboards and wine coolers, or that our harpsichords stood on lyres instead of legs; that constructive truth, in short, was wholly and entirely disregarded, so that some favourite type was reproduced? Was it to be wondered at, moreover, that men broke loose from these dead shams, and, getting sick of these classicalities, ran away from constructive truth and symmetrical arrangement altogether? went mad first after rococoism, and then, in our own days, after picturesque naturalism, and that the very revolution of taste produced the wildest contradictory faults.

Beauties arising out of constructive necessities.

90. It has already been remarked that true construction includes the proper use of materials; and it might be added that much of what is ornamentally constructive will naturally arise from this source. Thus, how much of beauty in architecture is owing to the arch, at first no doubt a structural necessity, arising out of the insufficient size of the blocks that could be quarried to bridge over the wide spaces

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and intercolumniations of the trabeated system in large buildings. Or to the tracery formed by the ribs of groins in Gothic architecture, necessary to combine lightness with strength! How much also of real character and even of beauty is to be observed in the displayed construction of our old timber houses, with their quarterings and braces, their projecting bays, carved knee timbers, and pierced bargeboards; things apparently tending to an unpromising effect, but when honestly treated, contributing to picturesque beauty and character. So also it might be with our brick buildings—a necessity of our geographical situation on a vast bed of clay, where stone is a costly material—if treated in good faith, and not hidden by the smooth hypocrisy of stucco. How much of life and vivacity might be given to the dull monotony of our streets by the varied interchange of their colour, helped perhaps by coloured surface glazings, which would resist damp and smoke, and which, but for the cheap facility of cement, would surely have been perfected long ago.

Importance of attention to the use of materials;

91. The limits of a report will not allow of this subject being entered upon at any length, or it might be fully shown how much that is of importance in "design" is contained in the right use of materials. What is true of stone, of brick, and of wood, is true also of metal. How diverse, for instance, is, or should be, the whole treatment of cast as compared with wrought metal—take forged and cast iron, the lightness and elegance obtainable in the one, contrasted with the necessary solidity and weight of the other: the play of form, fancy, and variety obtainable in wrought iron, now alas! almost wholly laid aside for the heavy, mechanical, commonplace repetition of cast work. Even in minor constructive operations the true use of materials often evolves the true ornamentation; as for instance, in weaving, as contrasted with printing processes, in basket weaving, &c. &c.

especially at the present time of change.

92. Our age is an age of new materials and new processes, which want carefully considering with a view to evolving for them and from them new and appropriate design. Gutta percha and electro-depositing, equally with iron and glass as building materials, should have earnest study on the part of the artist, not necessarily to make the one do *cheaply* what wood carving and metal embossing and chasing accomplish, or to bind the other to the five classical orders, but to find the right use of the materials and the decoration *consistent* with that use.

Seen in the Crystal Palace of 1851.

93. It is worthy of remark that the true novelty of our own time arose almost fortuitously out of the *useful* applica-

tion of iron and glass treated honestly in construction in the Palace of Crystal of 1851. More earnest study on the part of the artist may be expected to give more artistic combinations, combinations not arrived at by their mere juxtaposition in the stone and iron construction of the Champs Elysées.

94. If there is one rule more than another which may lead us to a style characteristic of our own age, it is that of making the purpose and utility of our buildings or furniture, and every object and utensil the first consideration; then the proper materials, by the use of which that utility may be most completely obtained; and, thirdly, ornamenting consistently with the nature of the material the leading forms arising out of such construction, irrespective of the mere reproduction of the bygone elements and ornamental details of any style. And reverting to what has been already said, that all the great æras of style have been æras of changed construction, it may not be too much to hope that the mighty constructive works of our days, and the changed materials of construction, may at last originate some characteristic style, which, impressed with the "mind and body of the time, its form and bearing," may give the nineteenth century characteristics as strongly as the eleventh were marked in the ecclesiastical styles that then arose.

Utility to be considered before Decoration.

Ornament second to utility.

95. The terms of the third proposition are, that as construction necessarily implies a purpose, utility must precede ornament. In all arts applied to things for the use, convenience, and comfort of man, from the building which shelters him and the objects of his care, to the meanest utensil which he values enough to desire to render it ornamental, the utility and fitness for intended purpose is or ought to be the first consideration. It has been said that design must commence with the choice of the first structural form and the best use of the materials to be employed, and afterwards proceed to the enhancing, enriching, and ornamenting that utility, or, in other words, in accordance with the well-known rule, we must ornament construction, not construct ornament.

96. This seems an obvious and almost unnecessary proposition, but it is often completely overlooked; yet, if kept prominently in view, it would correct such grave errors, that it is worth being earnestly enforced and constantly repeated. Thus, with respect to the external structure of both public and private edifices, the errors that arise out of useless constructive ornamentation have already been

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shown. Nor are the faults *within* the building, its furniture, its decoration, or its utensils, likely to be less grave, from the neglect of the principle of the prior claims of utility.

Various conditions of utility.

97. The way in which utility must control decoration is not always so patent as might be inferred, and oftentimes requires most attentive study and research. Thus, after the consideration of the general uses of any building, must come that of its individual apartments, regulating and characterizing the decorative treatment; and the hall, the library, the dining and withdrawing room, should each be considered having regard to their separate uses.

98. What, for instance, can be more practically absurd in a public building, serving as a picture gallery, than to cover the upper part of the halls and ceilings with pictorial subjects, surrounded by gilding and coloured decoration, whose coarse execution, vivid colour and brilliant "entourage," call away the eye from, and quite overpower, the more modest and thoughtful labours of the easel? Would not utility at once suggest that the character of the decorations should be sufficiently grave and simple, quiet and reserved, to support and display, without interfering with those far more valuable works of art? Yet in many of the galleried apartments of the Louvre used for the display of easel pictures, the very reverse is the case, and the walls and ceiling are redolent of decorative painting and gilding.

99. So also, in many of our private houses, you will see those who have spent thousands and tens of thousands on rare and costly works of art, sacrificing them entirely to a gaudy paper, manufactured decorations, or glaring carpets. Here *utility* would at once set the inquirer right.

100. Again, how often do we find cabinets so covered with carved ornaments, that they will not open, so embossed with useless reliefs that it is dangerous to come near them, so heavy that they hide without exhibiting the invaluable rarities they are made to contain; rich and costly buffets, that have neither sideboard for the dining utensils, nor shelves for displaying the plate (see Report, p. 309), chairs that give no repose to those that sit in them, caskets that are a misery to their possessors, as being too fragile to be touched?

English cabinet furniture examples of utility and good workmanship.

101. There can be no doubt that our English cabinet-work is far beyond that of other nations, and that for plain but sound workmanship, including easy action, excellence of framing and joinery, substantiality, and general utility, a chest of drawers, a sideboard, or a table, by Gillows or Snell is unequalled by foreign workmen, and if not exactly

beautiful, is certainly not vulgar. But when beauty is to be added to this utilitarian excellence, we are too apt to have "upholsterer's ornament," in the shape of some coarse scrollwork, or some Louis Quinze coquillage, originally intended for gilding, but rendered heavy, clumsy, absurd, and essentially vulgar, by carving it in the same coloured wood as the furniture; and when a still more decorative work is required, rendering the usual shop carving insufficient, utility is at once thrown aside, old constructive ornamental forms are resorted to, and too often a useless piece of ornamental lumber is the result.

but not of decoration.

102. Nor is the latter case very different abroad: in a large number of works in the Great Exhibition, the designer has constructed ornament, and forgotten use altogether, and the result is shown in a heap of massive, rich, and useless furniture, sideboards that will display nothing but the skill of the carver, and cabinets that are too often a museum of natural curiosities in themselves. This extravagance of design is led up to by the ability of the French art workmen, whose skill in carving fruit, flowers, animals, and the human figure, may be some excuse to the artist in his attempt at its display.

French cabinet-work often faulty in the contrary direction.

103. Of this character was the bookcase carved in pear-wood by Geurét Brothers; it appeared as if the whole structure had been grown over with a nondescript creeper, a cross between ivy, vine, and convolvulus, yet treated with an affectation of precise imitation. Sometimes the gnarled and knotted stem that twined over the work like a coarse cable was broken into joints as the vine, then the same stem put forth sprouts of flowering convolvulus, or budded into ivy with clustering berries, into roses or fuscheas; a strange attempt at naturalism without nature and ornamentation contrary to ornament.

Examples of utility sacrificed to ornament;

104. A work of even more elaborate *inutility* was the cheffonier exhibited by M. Ribaillier, jun., F. 7,991, bosky with imitative renderings of vine stems, grapes, leaves, flowers, and foliage, wherein birds have built their nests, which are curiously carved straw by straw. The panels are sunk much below the surface of the work, to allow of higher and more detached relief, and the whole of the framing, stiles, and rails, as well as panels, embossed, and knotted all over with carving projecting four or five inches from the surface of the work, while to complete the description, a nest is perched on the branches just level with the shelf or slab, for which two birds are fighting (no doubt to show the skill of the carver in the treatment of ruffled feathers), but whose forked wings and sharp beaks are more

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likely to injure those that come near the furniture, unless the whole was to be shut in a glass case or guarded by a rail, since the birds project full *ten inches* from the surface of this small piece of furniture. The subordination of ornament to constructive form is wholly disregarded, and the carving, though extremely clever and skilful, is quite out of place.

and of ornament subordinated to utility and construction: English examples.

105. The sideboard in the Gothic style exhibited by Mr. Crace is, on the contrary, a good example of construction decorated, and an excellent specimen of manufacture, without pretending to be a work of fine art. The form has been thoroughly considered for use: it is what it proposed to be, simply a decorated sideboard for dishes and for the display of gold and silver plate, with a protecting canopy above. The construction has been properly attended to, as well as the material (oak) of which it is to be framed. Stone forms there are none, either of column or architrave. The framing is all right-lined, therefore the wood all used in the direction of the fibre only. Arches, inconsistent with the right use of wood, have not been attempted. The carved ornament is all within the scantling; consequently any appearance of being applied, as in the two last-described works, is entirely obviated; and without aspiring to be more than workmanlike its carving is strictly decorative in its character: the back is lined with plain red cloth, that there might be nothing to interfere with the richness of the plate, while in the cove of the canopy a flat gold treatment of the vine and pomegranate served to carry into the furniture a repetition of the gold of the plate displayed. As a whole the work is a very instructive one, although not perhaps very original, yet rich without pretention or excess, it is entirely subordinate to uses, and to its own proper rank as a piece of furniture.

French examples.

106. When French furniture is treated simply and without excess, when the utility of the object is considered, and it becomes more essentially an article of furniture and less a mere ornament; the beautiful execution of veneers and inlays, and the varied treatment of surface, by the French workman, results in highly praiseworthy and excellent works, the taste of which makes us wish that a less pronounced mode of decoration were more generally adopted. Of this character was the beautiful escritoir exhibited by Fourdinois, it was entirely without carving, simply veneered, and inlaid with the choice woods, the products of Algeria, admirably contrasted, however, for colour and richness. A small cabinet in ebony, with inlaid stones, executed by Messrs. Grohé Brothers, is open to the same praise, and it

is highly satisfactory that the simplicity and excellence of these works were appreciated by an Englishman, both of them having been purchased by the Duke of Hamilton.

107. Allowing that "design" includes both construction and ornamentation, and that this latter should arise naturally out of the appropriate decoration of suitable materials, we shall arrive at a law of good taste, which, while it applies to architecture primarily, is equally to be observed in regard to the furniture and fittings which buildings contain, and which come more particularly within the scope of the present report. If in architecture, for instance, it is false in principle as it is weak in invention to impose on the face of a structure meaningless columns, purposeless porticoes, or useless pediments, it is equally so to make cabinets, armoires, buffets, or bookcases into miniature temples, with columns which, so far from having anything to support, are moved from under their entablature whenever it is necessary to open a door, and niches equally useless, trenching upon any space which may be devoted to purposes of utility.

Faults arising from naturalistic decoration.

108. Yet in these adaptations, we have precedent to guide us, and some sort of architectural rule and lore to refer to. Far more erroneous is the taste when extreme natural imitation is adopted, and a piece of furniture looks less like the work of man than nature's own growth, decayed and withered on some old wall or ruined paling; so much, in fact, is this the case, that the suggestion has not been lost on designers, who have *improved* it into a reality and rendered the stiles and rails of their works into the crumbling wall and broken paling, carving on them the brown, shrivelled, and clinging ivy. Many such examples were shown (beautifully executed) by Tuban, Macquet, and others. A jardinière by Tuban was actually treated as a *ruined château*, and the true flowers arranged and displayed as growing out of its dilapidated roofs.

Redundancy of French ornament in furniture;

109. This building up of mere decoration, this redundancy of ornament, is largely prevalent, and indeed may be called the vice of all French works, for the construction of ornament is by no means confined to cabinet furniture alone, though the illustrative descriptions have thus far been chosen from that class of objects from its being supposed that their size and importance must have brought them prominently under notice. The same fact might be exemplified in their works in the baser and more precious metals, in their toilet fittings, and, as far as impertinent ornamentation goes, in their carpets, hangings, and garment fabrics also.

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in fancy goods.

110. The French love of redundant ornament was particularly shown in all those classes of goods which come under the denomination of "objects of luxury and fancy articles," such as coffrets, caskets, jewel cases, chimney ornaments, dressing cases, mirrors, and indeed toilet necessaries generally; those exhibited by French manufacturers were curiously contrasted in their extreme decoration with the more simple utilities of the same class of goods exhibited by our English manufacturers, or even by those of Germany. And from the admiration they excited in the minds of the superior class of French visitors, it would seem that even the most extravagantly ornate were thought "very genteel!" "very original!" "very beautiful!" in their eyes, if we may judge from these constantly recurring exclamations. Yet it was not uncommon to find on the same coffret coloured veneers and inlays of wood, gold and silver mountings, china plaques, cameos, mother of pearl, glass, miniatures, and enamels. While the subjects of peace and war, of night and morning, of the graces and muses, in all and every of these kinds of enhancings might be found in heterogeneous mixture on the same casket; and that, perhaps, of the most costly kind and workmanship, and therefore appealing to a high class of purchasers. In one large case in the nave of the Exhibition (a sort of Paris court), many of the chief houses exhibited together; the works consisting of these "*objets de luxe*," goods suitable for presents, &c., and these fully bore out the impression derived from a more general examination, that French taste permitted and required an amount of ornamentation that would be pronounced vulgar and in excess by the better class of English purchasers.

111. Examples of extravagant and florid ornamentation were fortunately more rare in the British furniture in the Paris Exhibition, a striking contrast in this respect to our display in London in 1851. This, however, it is to be feared arose less from actual improvement on our parts than from unwillingness to enter into competition with the skilled workmen of France. It was, nevertheless, extremely fortunate, since works in bad taste are doubly objectionable when timidly and unskilfully executed; when wrought with the skill and intelligence of the French art-workmen we are compelled to admire the details, and are apt to tolerate the defects in consequence of the beauties.

in French carpets.

112. It has been said that the excess arising from considering ornament before utility was evident in other classes of goods besides those already enumerated; in none was it more evident than in French carpets.

113. The utility of such works would suggest their being quiet and unobtrusive in their general decoration, even if rich and full of colour. All violent and startling contrasts, either of form or colour, which would draw the eye to them, should be avoided, and *pictorial* imitation would seem the more out of place the more excellent it is, in a work to be trodden under foot and intended rather to support the general effect and richness of the apartment than to command attention for itself.

114. Yet nineteen twentieths of the carpets exhibited by French manufacturers, even of those manufactured in breadths, were pictorially treated; not merely with imitative flowers, but in many, combined with landscapes of various kinds, so that the possessor would have to walk over repetitions of sky and water, of palm trees and peacocks, of vases and fountains, mimicking each other at every step. Good taste in England has advanced beyond the thousand repetitions of the Crystal Palace, or the Duke on horseback, on the walls of our rooms and the blinds of our windows, and even in the cheapest kinds of carpets of repetitions of the like kind. It becomes therefore a curious question why designs of this character still prevail in France.

Inquiries as to the cause as respects carpets.

115. This would seem to have arisen from the initiation of the manufacture in the Royal establishments before spoken of; herein the workmen were employed in producing repetitions of the *pictorial* works of the great artists of Italy and France, intended as tapestry hangings for walls; and, as luxury increased during the period of the last Louis's, extending to objects of still life, fruit, flowers, game, &c., treated pictorially for portières, screens, for the decorated panels of apartments, &c. Some of these establishments continue to the present day to produce works of the same kind exclusively for the use of the Royal palaces: the designs are by the best artists of France, the skill and workmanship being of the highest excellence and beyond anything produced at the present time in any other country. The state of the manufacture was exemplified in the beautiful works from the Gobelins and Beauvais, in the pavilion of the Panorama, all aiming at a *pictorial* rather than a purely ornamental standard of excellence.

116. It has not been the practice in France to cover the floors of dwellings with carpets, as is the case almost universally in England. The floors being composed of parquetage of various degrees of ornamentation, it is the custom merely to lay down a small piece of tapestry here and there for the comfort of the occupant, leaving the floor of the rest of the chamber bare, and thus the pictorial art applied

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to the fabrics manufactured for hanging on walls gradually descended to the floor.

117. It is not to be wondered at, in view of the great excellence and world-wide reputation of the productions of these royal manufactories, both for works of the kind which in our sense of the word are called tapestries, as well as for woven fittings for furniture and carpets, that the general manufacturers of the country should aim at producing like works. Moreover, one of these great national establishments (that at Aubusson) has been given up, and the manufacture located there is carried on by private enterprise for the general market. Naturally an endeavour is made to continue the high reputation of the heretofore exclusive production, and they apply the same character of art to the staple manufacture for general uses, as had been heretofore applied to the art-manufacture for peculiar uses.

Nature of the tapestries wrought in the Royal manufactories.

118. The use of the beautiful woven pictures wrought in Gobelin tapestry to fill the gilded compartments of the rich furniture and decoration of Louis Seize, has had another effect on the general design for carpets. Not only is a pictorial treatment of the details, such as fruits, flowers, shells, game, &c., adopted, but the very gilded or ormolu mouldings that have surrounded and framed in the tapestry on the walls are represented also on the carpet, the compartments of which, in the great majority of cases, consist of imitations of coarse metal scrolls and coquillage in high and strong relief, a proof, if any were wanting, of how insensibly the eye is led into error by the things constantly before it.

119. It may be advanced as some excuse for this character of design, that it agrees with the style of ornament called Louis Quinze, so prevalent in many parts of France, and that where it is desirable to have unity of character in the furniture of a mansion it is necessary to adopt it. This, however, cannot be urged with regard to England, and it is to be hoped that the meretricious display of showy works of this kind at Paris will not have the effect of making its false splendour fashionable here.

120. It is also to be remembered that utility may be departed from, and over-ornamentation be produced by a false or excessive use of colour, with which, indeed, most of these works are chargeable. It does not suffice for true excellence that rare skill is shown in the gradation of the various tints, or rare brilliancy has been obtained in the dyes, or that even the individual pattern has been well and harmoniously arranged. It is the effect of the whole that is to be considered, and its due subordination to the general

effect of the apartment, and to the other furniture. But this will be noticed in the fifth proposition.

THE ORNAMENT OF ONE MATERIAL UNSUITED TO ANOTHER.

The ornament of different materials not interchangeable.

121. With regard to the fourth consideration, that "design must be bad which applies the same constructive forms and ornamental treatments indiscriminately to different materials."

It has already been shown that the due ornamentation of construction produces unexpected beauties in architecture, and this is no doubt the case also with those secondary objects of furniture, utensils, and fabrics, which are supplementary to architecture. Moreover, some remarks have been made on the architectural faults arising from the misapplication of decorated constructions to other purposes and materials than those for which they were originally designed.

122. Each material has its own peculiar constructive qualities; stone of homogeneity of texture and strength, its weight and mass rendering it extremely suitable for arched construction; wood of continuity of fibre, and strength conjoined with lightness, rendering it available for bridging over wide spaces, and from the direction of its fibre necessitating right-lined construction rather than circular or arched; metal of strength by tenacity of fibre, combined with a large amount of homogeneity, giving equal capability with wood for crossing wide spaces, with less bulk of material in proportion to weight than either that or stone, and, from its tenacity, for either right-lined or curved constructive forms.

Ornament must be studied in relation to the particular material;

123. As to the decoration of these several materials, the homogeneity of grain in the stone, and its perfect freedom under the tool, admirably adapt it for carving, but necessitate a different treatment to that for the continuous fibre of wood. The latter will bear more finesse of execution than the former, and a more detached relief; the colour, as light or dark, or veined and mottled, the hardness or softness, the intractibility or freedom of the grain in wood, moreover, require peculiar renderings of the ornament; while metal, whether the ornament be cast, chased, or embossed, evidently demands a totally different treatment to either.

its local position must be considered;

124. Again, the position of the ornament requires special consideration, as, for instance, its height above the ground, or point of view, which will govern both its relief and execution; much more varied quantities, bolder relief, and coarser execution being not only allowable but absolutely necessary at great heights above the eye.

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125. The practice of cutting the ornament after the stone, has been placed in the structure, so universal with the best Gothic carvers in mediæval times*, and still practised by the French workmen, admits of a right estimate of the true relief and just quantity of ornament, but from this very circumstance, (its relation to situation,) the mere reproduction of such ornament is often very unsatisfactory; for it must be remembered that the fitness of ornament for its special situation, and for the peculiar material in which it was to be wrought, was a necessity in its first production, but is overlooked in its mere imitative repetition.

126 If then the translation of ornament, even from one position to another, requires that it should be greatly modified and changed, still more so is this the case when the material in which it is to be wrought is changed also.

The heavy scroll-work of a Roman frieze carved in stone, although appropriate in its place far above the eye, must be quite unsuitable carved in wood as the back of a sideboard, and still more so, cast in iron as part of a gate or a balcony, where it is not only close to the eye, but pierced through between the foliage, which in the original was backed out and supported by the ground from which it was carved. Still more absurd is this same scroll-work imitated in relief on a carpet or tablecloth, or a muslin curtain. Yet such anomalies are continually occurring, arising perhaps from the use of casts of antique ornament as a means of study; their beauty becomes so impressed upon our minds that it is hard to appreciate fully their unsuitableness for every purpose.

and its nature, whether in relief or flat.

127. In this respect, indeed, originality is less to be hoped for in each succeeding age. As a writer is sure imperceptibly to reproduce something of the works he has read, so the artist cannot forget entirely those works through which his studies have been conducted. The path to excellence may be shortened, but other minds have set up their landmarks upon it. Thus studying art, as we must do, in and through art, nature is apt to be overlooked, propriety is apt to be overlooked, and fitness to be disregarded, and all that we do to become more or less a varied repetition of what has been done before.

The various qualities of the fabric must be

128. Moreover, each fabric and each material has its peculiar texture, lustre, &c., and even when uses are the same the translation of ornament from one fabric to another

* An instance of this may be seen in one of the west towers of Rouen Cathedral:—the stone is built into the structure with the requisite projections, but much of the carving has never been completed.

is often productive of very bad taste. Thus in the case of woven hangings, what might be suitable and beautiful in silk would be dull and heavy in worsted, and coarse and extravagant in muslin. The same holds good in garment fabrics also, where forms that may be unobjectionable in silk of a self colour would be large and extravagant in varied colours, and utterly tasteless in a printed de laine. Thus ornament must be studied for the special material it is to be wrought in, or however agreeable when seen on paper as a design, it will be likely to be in bad taste when executed.

studied by the designer,

129. Again, each mode of execution has its characteristic qualities, and each produces its own peculiar and varied beauties, and thus requires its special application of ornament; and this is one of the difficulties of manufacture, which renders it barely possible by the machine and the particular material to be used, to render all that the mind and hand has shown in the design, or to give in the design all that the material will add to it of lustre, beauty, or richness; difficult, indeed, it is, and requiring long experience in manufacture, to tell how a design will work; and connected with this difficulty is the appreciation of the changes that must take place in translation to produce the effect sought for. Nor does the consideration end here. There is still the difficulty which remains to the purchaser, and requires an effort of judgment, of which many are wholly incapable, to know how the decoration of the material will appear in use. Thus a garment fabric may be beautiful in itself, but look ill when made up for wear, and a silk hanging or a paper hanging which we admire in the pattern may, and often does, disappoint us extremely when it is hung; and this supports a former remark on the appropriateness of ornament being governed in some respects by position as well as material.

and by the purchaser.

130. As the lustre and brilliancy of silk are to be considered in its ornamentation, the material itself lending so much beauty to the design wrought in it, so there are many other cases wherein the material has a rare beauty, which must be preserved, sometimes arising from its purity and translucency, as in the case of glass and white marble, sometimes from its colour, as in ivory, sometimes from its beauty and purity of surface, as in porcelain. Thus, as it would not be desirable to paint marble or to stain ivory, neither is it desirable to destroy the whole surface of porcelain by decoration, however rich or however beautiful.

131. The errors arising from the miscellaneous application of ornament to materials were but too obvious in many

Instance of erroneous treatment.

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works in the Great Exhibition, and will be alluded to afterwards as they arise. A curious instance of inconsiderate imitation, where, from a misunderstanding of the material, the achievement of the intended effect was impossible, was to be seen in the Bordeaux bookcase exhibited among the French furniture. In one of the principal figures an attempt had been made to give the appearance of the features under a veil, as was so curiously done in a Milanese marble figure in the Exhibition of 1851. There the result was achieved from the sculptor having had a full appreciation of the assistance to be derived from the translucency of the marble, but in transferring the attempt to wood, with its solidity of structure and contradictory veining, the effort was ludicrously unsuccessful.

On Unity of Style and Decorative Subordination.

The principle of unity of style,

132. We have yet to consider that unity of style and proper subordination of one work to another, and to the whole external and internal decoration, which is so necessary to true taste.

133. It has already been said that there must be some predominating influence, some prevailing sentiment present in the minds of men to produce a style. Did this influence really exist, it would be seen in all a man possessed, and unity of character in his house and all the furniture and chattels it contains would be the necessary result.

observed in the Gothic period,

134. In the mediæval times this predominating sentiment was the respect of the many to the outward forms of a material religion; thus the aspect of all a man possessed was ecclesiastical—his furniture carved with emblems of the church, and his walls covered with the choice precepts of religion—as in the times of Judaism, when in the same spirit of outward respect the Pharisees wore the holy texts on the frontlets of their brows, and wove precepts, which they ought to have acted upon, into the borders of their garments.

135. In our own times any wide-spread sentiment is unfortunately wanting, and the greater number of even wealthy people are content to live in dwellings and to be surrounded with furniture totally incongruous in character the one with the other. This being the case, additions are made from time to time with the same careless indifference as to the harmony of the whole: each work is purchased for itself alone, with little reference to others, either as to style, to colour, or to relative subordination in decorative richness, till the house is like a museum, and the taste of the possessor being more and more vitiated and vulgarised, it becomes hard to impress him with any belief in the beauty which would

result, not from uniformity, but from the mere absence of incongruity.

136. It may be objected that the principle of unity or congruity, however observable in the mediæval period, was never attended to by the great artists of the renaissance, and that we continually see in their works and in their additions to other works, the strangest inconsistencies and anomalies. This is perfectly true, but it most probably arose from reasons quite apart from their rejection or recognition of the justice of the principle.

but disregarded by the artists of the renaissance.

137. These revivalists, coming with all the ardent enthusiasm of converts from the study of classic art, and convinced in their own minds of its ideal perfection and beauty, found the land covered with vast and magnificent temples and structures, deep in the love and reverence of what they deemed the *vulgar* public, and venerable from age and from consecration to God, yet of a style and character wholly opposed to that they sought to introduce. The reconstruction of these time-honoured edifices was hopeless, and the new race of architects began to seize upon and *adorn* the *interiors* of the old cathedrals and churches of Europe with rood-screens, stalls, altars, confessionals, pulpits, and monuments, in the new style of the renaissance, quite irrespective of the character of the original structure. In process of time they even ventured to make additions to the very structure itself. Thus, in our own country, Inigo Jones, not foreseeing the fiery purgation that was to prepare the way for the great monument of the new art, did not hesitate to build a classic portico to the Gothic structure of old St. Paul's; and it is impossible to enter the churches and cathedrals of France and Belgium and overlook how continuous was the endeavour to seduce the people gradually into the new faith in art, by additions such as those spoken of above. The apostles of the new faith did, in fact, but follow the practice and example of the early missionaries of Roman Christianity. These sought to humour the superstitions of the Pagan worshippers, and to wile them into truth by adopting, not only their festivals and holidays, but their temples and altars, consecrating them to the new faith, and at the same time smoothing down those distinctive differences that were most repugnant to their old belief. In our own day, and following out the same course of action, an eloquent writer on art proposes to revert to what he considers the sounder taste of our Gothic forefathers, by making piecemeal additions and alterations to our houses, and patching their bald and characterless horizontalism with gazebos and porches of a mediæval character.

The probable reasons.

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138. As was the result in respect to Christianity, where a like practice propagated all sorts of errors and superstitions whose parasitical growth nearly strangled the parent plant, so the various compromises and adaptations which architects thought reasonable in reviving classic art, have been the source of errors which have grown up side by side with it and by their grotesque absurdity marred the beauty with which they had common birth.*

Gothic principle of progress,

139. The Gothic principle of progress in style was essentially different from that of the renaissance. New and increased enrichment invariably began in the interior of the building, in the shrines, altar-screens, stalls, and monuments of churches, and the furniture and utensils of private dwellings (more particularly in the former however, as the style was essentially ecclesiastical), and gradually these enrichments passed from within the building, from its enshrinements as it were, to the decoration of the outside of the building itself. In the renaissance, on the contrary, as has just been shown, the constructive ornamentation of the exterior of the building became the model of the interior furniture and fittings, and hence many of the faults that have been already pointed out.

compared with the renaissance.

140. It is of the nature of imitators to seize on the most salient points, whether good or bad, and to exaggerate them; as a tasteless portrait painter caricatures a feature or expression in order to give a coarse and telling likeness. So the more recondite beauties of the renaissance, those which appeal to the highest minds, have been overlooked, and the grotesque and the novel regarded as the elements of the style, disregarding much in it that was spiritual and refined.

Nature of decorative subordination.

141. This very incongruity, a fault, perhaps a necessary one at the period of the revival, has been thus perpetuated as a beauty, while it is in reality an error and a mistake; for unity of style and decorative subordination are indispensable to true taste; all admit this in a degree, since none trust completely to indiscriminate selection. Most people allow a subordination in the apartments of their houses, and do not decorate the hall, the library, or the

* Even the faults and absurdities which were thus admitted are now so hallowed by time, and moreover offer such marked characteristics and illustrations of the age that produced them, that one would hesitate to suggest their removal, however much we may object to them as errors, and protest against their reproduction. There can be little doubt that the florid classic altars, the chubby cloud-borne cherubs, with their gilt palm branches, however incongruous with a Gothic cathedral, as truly exemplify the pretentious age of Louis le Grand, and the preaching of Bossuet, Bourdaloue, and Fenelon, as the writings and sermons addressed to it which these have left behind them.

dining-room so richly as the drawing-room or the boudoir. Moreover, there is usually some desire, often, it is true, with little knowledge, to have a due subordination in colour in the furniture of individual apartments, and there is at least an effort made that the carpets, the hangings, and the walls should have some harmonious agreement.

142. Is it too much then to assert that there should be a subordination as to uses also, and that the carpets and the wall-papers should be subdued and quiet, as forming the background of the apartment; and the chairs and tables, the cabinets and commodes, the mirrors and picture-frames each have such an amount of decoration, and only such, as is justly relative to their importance to the whole?

143. If this is true of furniture collectively considered, it is true also irrespective of this condition, and many of the gross errors, and much of the useless and improper expenditure, evident in all sections of the Great Exhibition, would have been avoided by proper attention to this rule, which would have prevented the production of the absurd and monstrous cabinets, armoires, sideboards, carpets, and hangings, which must be referred to hereafter.

Proper relation between the uses of an object and its ornamentation.

144. If the principle of decorative subordination is correct, it would almost follow that the uses of any object should be inferred from the nature and amount of its ornamentation. Could any one, from the following careful description of an object in the Exhibition, infer its use? It is inserted to show the value of the rule of decorative subordination, without which every apartment is like a picture without *breadth*, wherein the eye is distracted what to rest upon: tired and wearied with impertinent and obtrusive decorative parts quarrelling with each other, it is totally incapable of appreciating those rarer and more beautiful works of art or ornament which may be present, and which should be supported and led up to by the less important furniture around.

The value of the principle shown by its neglect.

145. Suppose a massive structure, some twelve feet wide and eight feet high, to stand before us, of which the following is, as far as possible, an accurate description. Three female busts, cut off just below the naked breasts, support on their heads an abacus which unites them together, composing a sort of leg, on four of which legs stands a heavy upright front of paneled work, to apply to which the workman's term of circular-circular would but poorly describe its tortuous curves, since it ogees inward and outwards, and backwards and forwards, as well as above and beneath. It is divided into three compartments, by what, as some name must be given, may be called twopilasters and two columns.

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To form the pilasters coarse dock leaves project from the front; on which fragile supports stand strange, fantastic figures, almost wholly detached: these balance flowers on their heads, on which flowers are the mouldings that curve into a sort of frieze, surmounted again by coarser shell-work.

The two columns, wholly disengaged, and touching the structure only at their bases, stand upon nothing, and are twisted like those in the well-known cartoon of Raphael, (the Beautiful gate of the temple), while large, naturally treated passion flowers twine in their convolutions. But, alas! instead of the cherubs that hung to the vines around the columns of that gate of beauty (perhaps the prototype in the designer's mind), opera girls, ballet-dancers, drummers, and cymbal-players, in every strange attitude, and to every scale, are hung to these, mixed up with fruits and flowers as big as themselves, dangling from panels of coquillage of the most indescribable shapes. The whole is crowned by a large Bacchic mask, writhing so as to leer down on the strange medley beneath it. It is a veritable frontispiece of Punch realized; realized in what? and for what purpose? The most random guesser would be nearer the mark than the sober truth will appear to be. This nightmare dream of ornament is nothing more than a large cast-iron safe from Luxembourg, for a staid merchant or matter-of-fact banker. The slightest attention to decorative subordination would have spared all this elaborate ugliness, and all the attendant expense. Even dry and unenriched utility would have been beautiful compared with such ornament.

General concurrence on the necessity of principles.

146. If the previous arguments are correct, it will be seen that the authority of antiquity in its best periods, the authority of nature as displayed in her works, the natural laws of form and colour, as well as the conditions and limitations of manufactures and the purposes of utility, are in favour of some such principles of decorative design as have been laid down. Yet, in looking to the works exhibited, and more especially those high-class works by Parisian artificers, such an entire absence of the control of these or like principles, such a thorough lawlessness is everywhere evident, that one begins to doubt if fancy should not be allowed to revel at will in such works, if we can be right and these in error.

Reason of their apparent absence: pictorial

147. There appears, however, one solution of the matter, which may be accepted in some degree as an explanation of the whole. It is evident that in nine-tenths of the manufactures exhibited, the law of pictorial art prevails rather

than the law of ornamental art. Now, although the office of a picture is to bring some object, some incident, some history or subject to the eye of the spectator, and to touch and please him with the passion, sentiment, or feeling which it is fitted to instil, it does this quite irrespective of the material in which or on which it is wrought. What have the canvass, the paper, the mere copper, or the panel to do with the enjoyment of a work of art? But ornament, on the contrary, if what has been said is in any degree correct, cannot be dissevered from the material, from which indeed much of its varied effect arises; and the character of the decoration adopted should be in accordance with the material, and with the uses of the object decorated. So much so ought this to be the case, that it might be expected that to see the design, or even a careful description of the ornament, would be sufficient to enable us to determine the nature and uses of the thing itself. How little this is the case, let the few following carefully written descriptions of remarkable designs and objects in the Exhibition demonstrate:

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law observed rather than the ornamental.

148. An outer border representing massive stonework, with mouldings carved in high relief, supports within it, by carved work at the corners, an inner carved moulding, apparently of stone, wound round with garlands of natural flowers. In the centre below, between the two frames, is a large, boldly carved cartouche, with tridents and cornucopias supporting the arms of Marseilles. In the centre above, the Imperial Eagle spreads his wings in the air, with crowns, sceptres, mantles, and jewelled collars, supported on an enormous stone bracket, while at the upper corners are two other carved brackets, on which also the Imperial bird flutters with outstretched wings. The remainder of the space between the two mouldings is a coloured ground powdered with stars. The whole forms a massive frame to a large landscape of the city and port of Marseilles, with its shipping and its palace standing out against the deep blue sky, while boats and craft of various kinds are floating on the quiet waters.

Description of a design in order to infer its purpose.

149. Such is the description of a design by one who has deservedly held a high rank as a skilful French designer. What is its purpose? A design, perhaps, for fitting up the side of some vast salon in the Hotel de Ville at Marseilles, with its stone carvings and enrichments, enshrining a picture or fresco of the port and its locality? No such thing. It is neither more nor less than a design for a carpet! Some mere fantasy of the designer, no doubt, and never intended to be executed? Again we are at fault; for wrought with great skill in flamboyant colour, behold it executed,

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and exhibited as a rare specimen of manufacture, no doubt, commanded for the especial place; a thing to be trodden under foot, and whose very excellencies are its greatest defects! Both the design and the manufactured work were rewarded with Medals, and the latter had been executed at a cost of 12,000 francs.

Another fabric extravagantly decorated.

150. But this may yet be exceptional and singular. Let us describe another. A mossy border, powdered with daisies, margins a square space wherein are clustered, as in a parterre, flowers of the largest size and gaudiest hues. From among these flowers grow groups of funereal yew, and through the openings of their interweaving branches are seen vistas of sunny landscapes, lakes, mountains, and clear blue skies. Above, the stag-like branches of the trees twine into fantastic compartments, in which or through which are seen, pictured in the upper air, manufactories with their tall chimnies, steam engines, implements of agriculture and of art, and groups of the products of industry. Then garlands of flowers dangle *upwards* far away into the canopy of sky, on which, as it were in the very vault of heaven itself, are heaped together grapes, bagpipes, bats, melons, pipes and tabors, pine apples, wheat sheaves, fiddles, pitchforks, and coats of arms.

151. This also, strange as is the description, is a carpet, worked for the city of Bordeaux at a great expense, and this, too, designed by one who has received many medals, the manufacturer being honoured by the Jury with a First Class Medal also. These are taken almost at random; notes of many other important works are but repetitions of the same characteristics. What wonder then that within the circle of the panorama nineteen-twentieths (this is said advisedly) of the carpets there displayed—carpets for the household not for the palace—were equally treated as pictures; very many of them consisting of flowers combined with landscapes, and of course as being made in breadths, repeating such pictures many times over the same floor.

Example of the same kind from a different section of manufactures;

152. But it may be thought that the design for one particular fabric had been led astray, and that such strange anomalies were not to be found in other works. Let me describe, then, another French design, which, it is to be presumed for its excellence, graced one of the trophies of honour on the day of the distribution of rewards. Oriental ornament, in good taste, and of a flat treatment, divided the several compartments of the design from one another. In the central compartment, in all the glories of colour relieved from a dark ground, was a pictorial representation of a Swiss cottage, embowered in trees, with a lady from the upper

gallery overlooking her maidens, who are working amid the parterres, and watering the flowers of every hue that grow in them. In the surrounding spaces, equally naturally treated, was a series of landscape subjects most elaborately and minutely wrought: in some cavaliers rowed boats and tinkled guitars to ladies lounging in flower-festooned temples: in some bronze fountains threw their jets against blue skies, and peacocks spread their hundred-eyed tails. In others, peasants gathered golden oranges from the laden trees, casting them into the laps of the maidens below, whose kids and goats browsed on the shrubs and flowers around.

153. Nor was this exhibited only as a design; it became also a manufacture of the most costly character, the difficulty of producing it being enhanced many fold by the nature of the subjects, which, one would presume, therefore, were highly characteristic of uses, or extremely beautiful in their adaptation. And what was this use? A silken shawl, not made for a half-barbarous people, but to be folded and to hang in folds around some lady of fashion, and for which purpose colour and textural richness would tell far more than all this ill-bestowed and ill-suited labour. What wonder, however, that as the house had been honoured, and no doubt deservedly honoured, for its skill in manufacture, with many medals and crosses, that numerous other shawls of the same character clustered round this rare effort of taste and skill.

154. One more description, and it shall be the last extract from an overflowing note-book to tire the reader and tax his patience. It shall be of quite another character, yet representing also a numerous class of like objects, for it is the object itself that is now to be described:—A paneled base is profusely covered on its stiles and rails with the fruit and flowers of the four quarters of the globe; the mouldings, usually the place for enrichment, are left plain, but within them, on the panels, groups of guns, casks, bottles, weapons, and all sorts of musical instruments, are heaped together in bold relief. The whole is surmounted by a flat platform, on which, almost wholly occupying it, sitting as it were on the bare board, without cushion or pedestal, in the most commonplace postures, are four figures the size of life: they may be compared to Turks on a bazaar, except that their legs in various attitudes dangle over the guns and bottles of the front. Behind rises a strange superstructure in three compartments. The two outer ones being niches, whose curved and broken canopies rise behind from dwarf winged terminal figures, while the fronts are supported by

and cabinet furniture.

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palm or plantain stems twisted round with leaves and flowers. The centre compartment—the principal one—is a large tablet, where sculptured figures of all sizes and in all reliefs, ascend from earth into the clouds of heaven: from Voltaire in the foreground, a host of wigged and pigtailed historians, poets, alchemists, orators, prophets, doctors, and geometricians wend their way upwards; while tangled in among the broken pediments above, winged Fames wave over them the palms of victory, and children representing fire, air, earth, and water, gambol on the pediments of the side compartments. Now who would guess this to be a sideboard carved in walnut? The board is absolutely useless: it is appropriated to the four bare-legged figures, who like brown lazzaroni loll there at their ease. The buffet where the plate is generally arranged is taken up with the apostles, philosophers, and doctors. Had the tablet contained an apotheosis of celebrated cooks, there might have been some reason for so honouring them; but why geometers, alchemists, &c. ascend to heaven at the back of a sideboard, seems to be beyond the rules of ornament, if indeed it is ornament, to decide; the more especially when this crowded inutility has been produced at a cost of 46,000 francs.

On the National Aids towards Art-instruction in France.

Public instruction in art.

155. In reporting on the relative taste and skill of the manufactured products of these International Exhibitions, it is impossible entirely to put out of consideration the effort made in the various countries, either by the State, by municipalities, or by individuals, to promote the improvement of manufactures and the education of the workmen, since these may be supposed to have a great bearing on the general question.

156. As the contrast in these respects is most marked between our own country and France, it may serve our purpose to limit our observations chiefly to these two, the most prominent of the contending parties.

In France.

157. In France the early foundation of schools for the education of workmen in the elements of art has already been spoken of, and the existence of some public instruction to her artizans traced back nearly 200 years; as also nearly to the same period, the foundation of royal manufactories for the special improvement and perfection of certain branches of manufacture. Thus for tapestry, carpets, and furniture, and at a later period, and following in this instance the example of Saxony, for porcelain.

158. Nor must we imagine that in such manufactories, wherein the labours of the workmen and of production were carried on irrespective of cost, the special manufactures for which they were instituted were alone benefited. In prosecuting such manufactures, these noble establishments made diligent researches into all the collateral arts which were likely to tend to their improvement. Thus in the tapestry and furniture work of the Gobelins, not only would the designs be perfected under the direction of the first artists of France, but the researches into dyes and dyeing be diligently prosecuted by the first chemists of the age. Moreover, the most improved machines and modes of weaving were sought out. as well as those proper for preparing the worsted, silken, and metallic threads of which the tapestry was wrought: the most suitable woods for inlays, veneers, carvings, &c. were studied; and the combinations for producing agreeable effects and harmonious arrangements of colour, either by the contiguity of tints or the disposition of the threads, were the subject of continuous and careful experiments.

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Royal manufactories; their influence.

On art as well as science applied to manufacture.

159. Again, in the porcelain works of St. Cloud and Sèvres, the chemistry of earths, of pigments, and of the various fluxes, the art and requisite conditions of modelling, moulding, and painting, the methods of gilding, the qualities and application of glazes, the construction of wheels best adapted for throwing or turning the forms, and of kilns for firing the products would be assiduously inquired into.

French Academy of Fine Arts.

160. The foresight that promoted the institution of royal establishments, to advance the manufactures of the country, provided for instruction in art also by the foundation of an academy of fine arts one hundred and twenty years before an institution of a like kind was established in this kingdom. The funds for the support of its professors were derived from the State, and the regulations made from time to time for the admission of students into its schools have been of the most liberal character. Even the superior workmen of the capital—obtaining a degree of previous elementary instruction in the communal schools—find no serious obstacle opposed, by the nature of the competitions for admission, to their entrance for the instruction it affords.

161. These instructed workmen labouring in the noble establishments we have been describing, on designs of high artistic excellence; and competing there and elsewhere in the production of the highest efforts of skilled labour; overlooked also and directed by eminent artists and men of science, have created and continued a tradition of excellence that it is hardly possible to destroy, however it may be turned aside

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and misdirected. And to this day the mass of French art-workmen, however we may criticise the works on which they labour, are as a body deserving of all honour, and very far in advance of those of any other European nation.

162. All collateral arts would be likely to be deeply influenced and greatly improved by the unrestricted labours of the artists and workmen of the royal manufactories. And as these artists, men of science, and skilled workmen passed occasionally from the royal foundations to labour in private manufactories, we should be led to infer that they would exercise a decided and most beneficial interest on the general manufactures of the country.

Assistance from its members to manufactures.

163. Moreover, the artists connected with the French Academy of Arts, as well as those educated within its walls, taking example from the great artists of the 14th, 15th, and 16th centuries, who often united the actual labours of the sculptor, the potter, or the founder; of the painter and the goldsmith; of the architect and the decorator; were content to give their aid in designing, modelling, or painting for the higher manufacturers of the day. What Lebrun and Boucher among the painters, Perrault and Mansard among the architects, and Girardon, Théodore, and Puget, sculptors of their time, considered part of the art, their descendants and followers, the eminent French artists of the present day, have been well inclined to continue, and thus an intimate relation between fine and manufactured art having been once established, has been uninterruptedly continued.

Museums and palaces open to the workmen.

164. In France, more particularly in the metropolis, ornament and decoration of a high character everywhere surround the workmen. It had been the custom of her monarchs for many reigns to dine and even dress in public, and the halls and galleries of their palaces filled with the most diversified contents, and gorgeously decorated, were easily accessible; while the Louvre, the Bibliothèque du Roi, the Musée d'Artillerie, and the Hôtel Clugny, at least of late years, have exposed their wondrous art treasures to every gaze.

165. Moreover, in these palaces and galleries of art and rarity, the works they contain are not only open for the inspection of the workmen, but, subject to no very stringent restrictions, for study by copying also; and the large demand for skilled artizans to decorate the salons, the cafés, and the theatres of the great city, is a sufficient stimulus to men to avail themselves of this source of improvement, while the publication of valuable works of ornamental art becomes a necessary consequence, and an increased source of instruction.

166. The royal establishments so often alluded to had resulted in the production of a vast number of pieces of furniture of a style totally different from any previous works, a style which, with many defects, admits of the widest range of fancy, the most unrestricted combinations of materials, and the most consummate workmanship. In these works every kind of treatment of surface by means of veneers of choice and curious woods, incrustations and inlays of all kinds, japanning, buhl work, and varnish work, by marquetry, and by inlaid plaques of china beautifully painted, was attempted and accomplished. Metal mountings cast, chased, or embossed with rare finesse, wood carving, and gilding, were employed to enhance and enrich them. This new style of furniture, in happy unison with French taste, formed a perfect school for training workmen in every artistic and manipulative process.

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Results of the skill of former periods.

167. So completely had the designers and artists of these works exhausted the resources of manufacture, and the various applications of materials, that all the efforts the last few years have called forth have failed to produce much real novelty: these still stand as the types of excellence, and the labours of the present race of Parisian workmen are largely devoted to reproductions of the specimens of that time.

168. By the effects of successive political revolutions and changes, these choice works have been largely dispersed, so much so, indeed, that it was hardly beyond the power of every little "chamber master" to possess himself of some piece, the skilled excellence of which might stimulate him into emulous rivalry.

Masterpieces of manufacture accessible to all.

169. It is hardly necessary to do more than glance at the fact that the like encouragement which is afforded to Parisian workmen has been given by successive French governments to aid in the education of the workman and the promotion of public taste in the great seats of industrial manufacture beyond Paris. Not alone at Beauvais and Aubusson where royal manufactories were founded, but as at Lyons or those other places where staple manufactures had located themselves: and this both by schools of art, museums, and picture galleries, as well as other modes of gratuitous instruction.

Instruction in Art in England.

170. Let us now compare the practice of England in this respect with that of our Continental neighbours. In this country, since the age of the Stuarts, there has been little attention paid to art by the Government, and no royal assistance in such matters. Charles the First, who was beyond his

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countrymen in appreciation of art, commenced a royal collection of pictures, which, if the troubles of the times had not intervened, might have been a lasting benefit to the country, and started us much earlier in the race of art. Moreover, in his reign a manufactory for tapestry was founded at Mortlake, in Surrey, in imitation of that patronized by Francis the First of France, at Fontainbleau. And afterwards, on the death of the first director—and long prior to the Gobelins becoming a royal establishment—Charles purchased the works, intending that they should be carried on by the Crown. At the breaking out of the Revolution, however, they were seized as royal property by the Parliament, and, notwithstanding some endeavours to that end, were never successfully renewed. This was the last, and perhaps only instance of such a foundation in this country, although George the Second is said to have given some assistance to the china manufacture at Chelsea. The genius of the people and of the constitution seems opposed to such establishments on principle, and it has been found, in this country at least, that Government is the worst of manufacturers, even in those great works which are of necessity national; and this would be still more the case in attempting the production of works wherein taste and beauty are to be judged of as essential conditions of excellence.

Early attemps at galleries and Royal manufactories.

Establishment of the Royal Academy by GeorgeIII.

171. From the time of the Stuarts until the middle of the last century, very little native progress was made in art, most of the patronage being given to foreigners. In 1768, however, after some previous unsuccessful efforts at combination, the Royal Academy was founded under the enlightened patronage of George the Third, and most of the native artists distinguished in the various branches of painting, sculpture, and architecture, together with several foreign artists of reputation established permanently in this country, were included among its members.

The gratuitous instruction it affords to artists.

172. To this institution was England indebted, for more than half a century, for the gratuitous instruction of that great body of skilful and intelligent artists which since that period she has been able to boast of. George the Third, it is true, provided apartments for the Academy in one of his royal palaces, which have ever been continued by the Government, as is the case, indeed, to other institutions of a like nature, such as the Royal Society and the Geographical and Antiquarian Societies; but farther than this there has never been any aid from the public purse. The funds have been derived entirely from the exhibition of the works of the members, combined with those of other artists desirous of contributing. From these funds, besides the annual dis-

tribution of large sums to decayed contributors not of her body, the Royal Academy has maintained and still maintains most efficient schools of art, wherein gratuitous instruction is given to the students by the most distinguished of its members. And thus the fine arts of this country have been raised to at least equal excellence with those of any other country at the present day.

Instruction of the artizan unprovided for.

173. But during this period, what has been the condition of the English workman, and what his advantages in the struggle towards excellence? Let us consider the period including the first forty years of the present century, during which the larger number of our present artificers completed their education. Schools of art for the workmen there were none—next to none for the general public; for the schools of the Royal Academy were strictly intended for the education of artists, admission to them being obtained only by a long preliminary probation, quite incompatible with the time at the disposal of the workman and artificer, and nearly as much so with that of those who would desire instruction in art as a valuable part of general education. Moreover, it was necessary to enter as a professional artist, and a somewhat high standard of previous attainment was required even for admission to the probationary studies.

Nor were there any schools wherein art took an ornamental direction, either for the workman or for his employers, the only exception being a few schools for linear drawing, such as those of Nicholson, Green, and others, whose charges were far too high for the general workman; and even these were so exclusively linear that it was rare indeed to find one who could draw a piece of foliated ornament with ease and intelligence.

Few opportunities of seeing art or ornament.

174. Galleries of art there were none, or next to none, open to the lower public.* Our metropolitan palaces were hermetically sealed; our only museum contained, it is true, some rare specimens of Greek art, but these were mostly fragments, and the style was too pure and abstract for the wants and tastes of the age. Collections of art workmanship there were none, open either to the educated classes or the workman, whose sole opportunity, therefore, of seeing any sort of decorative art was by an occasional visit to the theatre, since it was banished from our churches; and cafés and the like places of resort have never consorted with our climate, or with the genius or the habits of our people.

* It is true that Angerstein's pictures were purchased by the nation and opened to the public in 1824, but the smallness of the collection, and the slowness with which the lower classes learn their privileges, hardly contradict this as a fact.

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175. Prints and publications on ornamental art were rare, costly, and within the reach of few, certainly not of the working classes. Very few of those who followed art as a profession gave any assistance in designing for manufacture, much of which was of the plainest utility, and gave the artisan but little opportunity of improvement in anything beyond sound, honest, and substantial workmanship.

The public equally uneducated.

176. That portion of the public who are the purchasers of more costly goods were almost equally uneducated in matters of taste and style; except perhaps the few that travelled, and who generally came home with a supreme contempt for British art, British taste, and British skill. Is it to be wondered at that under these disadvantages our manufacturers made such little progress in the production of what is beautiful, or that our workmen were far behind the foreigner in such matters? And yet the success of Wedgwood in the latter half of the last century at the Potteries, and at Chelsea of the china manufacture, prove that art-power and excellence were not wanting, had there been the requisite encouragement for British skill. The last few years, however, have seen a great and beneficial change, abundant appliances are now being given, in the way of primary and secondary instruction in art, by means of drawing schools, of picture exhibitions, and exhibitions of art applied to manufactures; by lectures and by the numerous works on art which are being prepared and distributed throughout the kingdom, and especially in the great seats of manufactures; and it may be hoped the latter half of the present century will show a greatly increased development of British taste, and place us somewhat on a par in this respect with our friendly rivals the French.

Great change for the better; sound instruction now offered to all.

Marked advance in taste since 1851.

177. Indeed, evidence of this is not wanting. It is not too much to say that a more marked advance was shown in the taste of British manufactures than in those of any other country in the late Exhibition; and while there is progress perfection may be hoped for. There can be little doubt that what the schools and exhibitions of the Royal Academy have done for fine art, in raising it to the high reputation it has deservedly attained, the Government art schools for artizans and the public—the art exhibitions throughout the land,—the museums founded in the chief cities, and beginning to be extended to all large communities, are now doing for art-manufactures; and that a patient continuance in the same course must have the same result, by raising the taste of the general public to demand, and that of the manufacturer and artisan to supply, a higher style of design; the only way in

which this country will consent to be dictated to in matters of production.

178. It would be unjust and ungenerous, in making this comparison between the two countries, to pass without remark the valuable assistance which British manufacturers have derived in matters of art and taste from foreign artists and workmen, and which our manufacturers themselves are always quite willing and desirous fully to acknowledge. Not only is this the case in the supply of designs for many of our great manufactures, but by the actual engagement of skilled foreigners, both artists and men of science, in many of our large manufactories. Thus in the potteries Messrs. Arnoux, Carrier, and Jeannest must be mentioned with honour as having contributed to the advance that is so apparent in the display of Messrs. Minton, and in the case of the last-named gentleman in that of Messrs. Elkington also. Messrs. Jackson and Graham were aided in the production of their choice specimens of cabinetwork of the Gauthier period by Messrs. Pregnot, Protat, and Phenix as designers and modellers, and M. Claudio Colombo, who carved the figures. The most artistic portion of the display by Messrs. Hunt and Roskell consisted of the beautiful works of M. Vechte; and this firm, in their catalogue, pay a graceful tribute of gratitude, respect, and admiration to the eminent taste that they have found in France to aid them in carrying on their large establishment. In addition to M. Vechte they mention M. Julien Billois as having formed and directed during many years their *atelier* of jewellery, which was continued under M. Adolphe Devin, now Inspector of the Crown Jewels of France. No doubt many other instances might be adduced if we were provided with full information on the subject, since the practice is quite in accordance with the usages of our great manufacturers, who seek out skill and ability irrespective of nationality, and are always willing to reward liberally the talent they employ.

Acknowledgment of assistance from foreign artists.

179. At the same time it is but just to these various manufacturers to notice how great an advance in taste and skill has, in many instances, been made by foreign artists while employed under British direction. It would seem as if the extreme and facile redundancy of French art, which would have been apt to run into extravagance and mannerism without this direction, was subdued into greater purity and refinement in this country. It is a subject of much interest to study the modifications by which this has been arrived at in the case of many works when the designs are evidently of French origin; but which, wrought out under this restrained use of means, are subdued and satisfactory. This was

Restraint on their redundancy by English taste.

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evident in several carpet designs exhibited by British manufacturers, which were far more amenable to good taste than the like style of designs in the French court.

Probable influence of Royal manufactories on general trade.

180. It is not undeserving of consideration here whether the general manufactures of France have largely benefited by the foundation of the royal establishments so often spoken of; whether, in fact, they have been of advantage to the staple manufactures of a like nature to those so fostered, inducing the production of goods of higher excellence for the general trade. There can be little question, as an endeavour has been made to show in the course of this report, that these national workshops have been the means of increasing the general taste of the public, and the general skill of the workmen, and have indeed largely contributed to the reputation enjoyed by France for high-class goods and for taste in design; and this not alone in the particular manufactures encouraged, but in all in which beauty and elegance are elements of success.

181. In so far, then, France has, no doubt, been greatly benefited by these establishments: they have led to a large trade in high-class goods and to the extended reputation of Paris as the emporium for them, and have produced workmen so far beyond the same class in other countries that in these goods she must long command the markets of the world and sit the mistress of fashion. But in regard to those manufactures which form the staple of commerce, and are suited to the large body of purchasers, their effect has not been equally advantageous, and from undiscovered causes, would have appeared rather to depress them; perhaps by the presence of unattainable excellence, and the fear to enter into any rivalry. Thus in china it is at once evident that the general manufacture of France, notwithstanding the example of Sèvres, is far below that of England, both in lightness and beauty of material and in execution; while in earthenware there is really no rivalry. In carpets again, the general production, both as regards suitable design, excellence of material, and beyond all doubt when these qualities are considered relatively to price, the comparison is altogether in favour of England.

In France.

Benefits derived from them by England.

182. It is creditable to England that a private manufacturer should have had the spirit to compete with and the skill to rival the works at Sèvres, and it is also highly honourable to France and to the Jurors in this Class, that they have affirmed it in their rewards. But there is no doubt that the excellence and originality arrived at in this country, have largely arisen, as far as porcelain is concerned, from the careful study of the earlier works of this celebrated

place. All our great pottery establishments owe a deep debt to Sèvres, since there can be no question, that much of the present excellence of our china is due to the efforts made by Minton, Copeland, Rose, and Daniel, first to copy, and then if possible to excel, the soft paste, the tender glaze, the sharp and skilful ornamental modelling, and the rich gilding of these works, the purity of the Rose du Barry, the depth of the Bleu du Roi, and the clearness and transparency of the Celadon green.

183. If in some of these respects the pâte tendre of England is finer than can now be fabricated where it was originally produced, it is because Sèvres has taken other aims—aims in which she has so far succeeded as to leave us sufficiently behind in the race to encourage further struggles for success where success would indeed be honourable, in emulating the skill of her painted art decoration or her modelled and artistic reliefs.

184. The former portion of the report, while it will have illustrated many of the principles of decorative art, will have also served as a preparation for entering upon a few more classed and particular criticisms of the works in the Universal Exhibition; both those displayed by ourselves and those from other countries. It will be seen that it has been thought necessary to approach the subject with some diffidence, clearing the ground, and making firm each footstep as we advance, and searching out causes which may have led to the defeats we had reason to fear in competition with France, whose superiority in matters of taste and design has been so long admitted to be supreme; claiming those allowances beforehand which may be made for British shortcomings, and inquiring into the national advantages of our skilled and ingenious competitors; the want of them by our own workmen; and whatever is hopeful for the future.

English prejudice in favour of foreigners.

185. Indeed, it has been so long the habit of others to assert, and of our own people to lament, British inaptitude for art, and to exalt the superior aptitude of foreigners; so much have we been taught to look up to France as our teacher in design, that any comment on our part on French taste will be thought like the pupil criticizing the master.

186. Nevertheless there must be some time when the student begins to judge for himself, and the very world-wide recognition of France's claim makes it beyond measure necessary to be satisfied that the abundant fancy of her designers, set off by the undoubted skill of her workmen, and the redolent enrichment and startling combinations of the products of her workshops, are under the guidance of principles leading towards greater and greater perfection,

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and fitting them as exemplars for other nations. Or whether the works we have been accustomed to look at with mingled wonder and admiration are capricious, misleading, and meretricious; subversive of that simplicity to which we can recur with ever increasing delight; and leading us, like false stimulants, to desire more and more of that which is pernicious to healthy taste and true excellence.

Skill of French art-workmen sometimes misapplied.

187. We have already alluded more than once to the skilled artizans of Paris, skilled not only in all cunning workmanship, but in those meretricious adornments also that minister to false taste and over-decoration. The carvers, the chasers, the gilders, the inlayers, and the enamellers of Paris are as cunning artificers in their day as the wise-hearted men that were inspired to decorate the tabernacle of old; their skill, however, is as often employed to deceive the eye, and make the false look true, and the mean magnificent, as to add value to rich materials by excellent workmanship, finished labour, and true art.

188. It has been said that the works coming within the scope of the report are too numerous for any detailed examination, but we shall be spared the tediousness individual remarks would give rise to, by looking principally at the *chefs d'œuvres* in various classes. These, from their very costliness, must be addressed to the most cultivated taste, and have been executed by the most skilled workmen. Among them must be found those labours that truly express the age; works that appeal to the discriminating few, and will mark the time of their production as an epoch in industrial art; works from which the manufacturer must go on to greater perfection, or which will remain for future times as tide-marks to show how high the waters had once flowed.

Designs.

Examination of French "designs."

189. As preliminary to our other labours, it is desirable to examine the *designs* exhibited; these are almost, if not wholly, French, and were in many cases open to comparison with the objects executed from them, which had also a place in the Exhibition.

190. Mr. Dyce, in his lecture on ornament, says, "the *principles* of ornament developed in Greek art, and in the art of the middle ages, are, so far as they go, true and determinate *principles*, the result of long experience, which nothing but ignorance can lead us to undervalue, and which we must learn before we can add to them or give them a wider range."

These *principles* are believed to relate not only to the general structural forms of ornament, and the symmetrical

arrangement and display of the details, both of form and of colour, including that amount of adaptation which subserves nature to art; but also to the suitable application of ornament to various materials, fabrics, processes, and utilities, as the former part of this report has attempted to explain.

191. In the examination of the works of the Great Exhibition of 1851, nothing was more evident than that these great *principles* of ornament had been forgotten or were almost entirely neglected; and this not only in British manufactures, but in those of all other European countries. In the East alone, that land of fixed ideas, had the full tradition of them been retained; the works from India then exhibited were found to be in perfect conformity with those principles which had obtained in Greece and in the middle ages, and the world was somewhat astonished to find that a people whom it had been accustomed to consider as semi-barbarous, had sent examples of the most refined taste in the arrangement of form and colour, and the adaptation of ornament to materials.

Excellence of Indian ornament.

192. In examining the British goods in the present Exhibition, far less extravagance in design is observable than in 1851; while in some fabrics and manufactures there is evidence of much greater attention to ornamental principles than formerly, and in all classes there are signs that the subject is obtaining a greater share of attention from the discussions that have arisen on the application of design to manufactures.

193. In France, however, judging not alone from the works executed, but more particularly from the greater number of the designs exhibited, there is no appearance of any progress towards the acknowledgment of principles; almost all is utter lawlessness and unrestrained extravagance, only less absurd than the banker's iron closet described at page 325, in so much as the refinement and beauty of the execution of the design itself has a charm as a work of art that is not present in the coarse realization.

Want of *principles* in French design.

194. Not that there is a total absence of correct principles in the application of ornament to manufactures in the French designs exhibited; but the works which evidence more appreciation in this respect are so extremely few; or there is often such a mixture of glaring error and incongruity in the same design; or of the most outré and extravagant designs by the same artist side by side with those in purer taste; that any truth observable is evidently the chance repetition of stores treasured up by the artist from the wealth of other periods or more correct eras.

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195. Thus, while some of the designs for silk goods exhibited by M. Chebeaux are in excellent taste, flat in treatment, fitted to show the beauty of the materials, to distribute form and colour agreeably to the eye and so as not to be interfered with by the folds necessitated in the uses of the fabric; others are naturalistic in their treatment, florid in the extreme, and quite unsuitable to display the beauty of the ornament in the use of the fabric. We have also by the same designer, shawls, which must be costly in the extreme in their execution, covered with purely pictorial subjects; such as Fame distributing her rewards to the representatives of the different nations assembled at the great concourse of Industry, or that notable one already described (p. 308). Again, there are designs for carpets, which, in place of that flat treatment, that repose, that negative and subdued harmony which is requisite for such fabrics in respect to their uses, would make us tread on pictures, and spread out beneath our feet landscapes and buildings, liquid waters and bright skies, as if in direct contravention of the rules of their own art-lawgiver, who says:—

> "In all to strict propriety attend,
> Nor sink the clouds nor bid the waves ascend." *

Over-ornamentation.

There are, moreover, designs for silk curtains, on which, as on a wall, are imitated in relief arms, armour, and plumed helms more numerous than those Scott described on the walls of Branksome; and armoires covered with arms outside so skilfully imitated that the sham weapons would rival those the armoire is meant to contain.

196. It may be said, perhaps, that these were only designs, the product of the teeming fancy or overflowing imagination of the artist; that they are not meant to be executed, but are rather evidences of the skill, the power, the inventive combinations of these talented designers. Alas! this is not indeed the case; the most fantastic, the most extravagant of the designs in this court have been executed—executed, in many instances, at enormous cost—and are among the richest and most prized of the manufactures exhibited, and both designers and manufacturers been rewarded with medals and honoured with crosses for these very works. Thus as the designers who invent, the manufacturers who execute, the judges who reward, and the people who purchase, are content to consider these enormities as the legitimate exercise of fancy and invention, we must regard them as the true standard of Parisian taste.

* Du Fresnoy on Painting, Mason's translation, I. 309, 310.

197. If in the invention of novelties we find strange anomalies in French design, this is often equally the case in their rendering of past or acknowledged styles, which they rarely preserve pure, and occasionally mix up with the strangest incongruity and error. Thus, if ruling principles are anywhere retained with rigid observance it is in the East, where art seems to descend, like caste, unchanged from father to son. But the shawl designers of France, while adopting some of the leading features and more striking details of Eastern art, do not hesitate to mix them up with all that is pictorial in European design. Many of these designs embody the well-known pine form of Cashmere, filled in, however, not only with flowers naturally imitated, or with landscapes, but, in one elaborate design, with miniature portraits of all the Imperial family and court, on foot or on horseback!

Want of correct appreciation of former styles.

198. It has already been remarked that the Gothic, as a style, finds little favour in France, and its details are rarely understood. This is seen in a design for tapestry for one of the town halls of France. A composition of the life, trial, and execution of the unfortunate Joan of Arc is framed in with an imitation of carved wood tracery, florid and flamboyant, coarse and incorrect. Even the tartans of our native Highland clans, which have an unchanged history of many generations, must receive enrichment at the hands of French artists, and their native simplicity, so applicable to the weaver's art, be filled in with *flowers* in the intersections of the checks. Thus it will ever be when we attempt to give "wider range" to design before the *principles* have been fully mastered. Here and there designs may be found approximating to correct taste, but the opinion forced upon us by examination is, that they are the result of chance and not of knowledge. Many of the designs, however, are most beautiful in their fancy and in their mere execution, while some of the studies of flowers (those in block tints by M. Lemeur particularly) are most skilfully and truthfully rendered.

199. M. Braun shows some beautiful photographs of flowers and foliage, with a view to their use in design; yet these but afford another instance of want of principles, and of that mere pictorial imitation which is the bane of ornament and the source of so much error.

Some designs by M. Clerget are an exception to the general florid redundancy; they are based on a careful study of the past, and being simple and unpretending, might be overlooked among the exuberant fancies around. They must of necessity be considered tame and unimaginative

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when compared with those whose cupidons and flowers, greffons and monsters, are scattered with an unsparing hand.

Its probable cause,

200. This strange want of correctness in the details of acknowledged styles, this mixing up of the ornament of different periods and countries, this misapplication of the ornament of one material to another, or of relief ornament to surface decoration, which is so common in French design and in French manufactured works, as has been over and over again noticed in the course of this report, is not unlikely to be in some degree fostered by the nature of the instruction in ornamental art in the Parisian schools.

arising from the mode of study in schools of art.

201. In visiting several of these schools, the rooms were found full of diligent, orderly, and earnest students drawing and modelling either the figure or ornament, both from flat examples and from casts. In no case did there appear to be any definite *selection* of the objects for study. A wretched modern lithographed head, or a classic example from Reverdin's work, a piece of Louis Quinze ornament of the most rococo character, or a fine example of Roman or Renaissance, seemed to be set before the pupils indifferently, and copied with equal pleasure. In some instances, the characterless ornament of yesterday was the subject of competition (*concours*) to-day. The whole aim seemed to be to give the student a power of drawing and modelling *form* boldly and readily; refinement seemed little thought of, discrimination not required, and knowledge of style and period not attempted to be given, except partially in the school under the direction of the late M. Belloc, in the Rue de l'Ecole de Médecine, where some black-board instruction of this kind was occasional.

Great dexterity of hand acquired, but the principles of ornamental art not studied.

202. This indiscriminate study of unselected ornament, while it no doubt gives great dexterity of hand and ready manipulation both in drawing and modelling, must confuse right and wrong, beauty and deformity, in the mind of the pupil; and unless some clear after-guidance is given (which does not appear to be the case), is too likely to result in thorough indifference to the principles of ornamental art, whatever may be the imitative power obtained.

The ornamental art of France very meretricious.

203. Thus reviewing French design in the face of the great reputation it has achieved, the beauty of much of its details, and the skill with which it has been embodied by the able workmen of the French metropolis, may appear presumptuous and bold, but it is done with a full conviction of the truth of the objections made, and of the danger of its obvious meretricious faults and errors. If not curbed, if not regulated by some rules, the unbridled fancy of the designers will lead to such a wild redundancy in the sense-

less copyists of other countries, that we shall sicken of ornament, and returning again to the dry undecorated utilities, lose that addition of beauty which, under due subordination and regulation, is necessary to our complete satisfaction; leaving the works of man devoid of that which is always found added to the works of the Great Creator.

204. We are more jealous on this subject, and more severe on French designs, because of the mission of France in the eyes of Europe, and towards our own country in particular. It must always be remembered that her designers and manufacturers are more unfettered than our own, more free to produce what is really excellent, since France manufactures for a high class civilization, for intelligent and educated Europe, who look up to her in matters of taste, and respect her decrees. England, on the contrary, produces for the masses and for the world's market, and is bound to consider her purchasers and their tastes,—the wants of the Sierra Leone negro, the Chilian guacho, and the Hottentot of the Cape, as well as the middle class consumers in more educated lands.

The next subject for examination will be—

Cabinet Furniture.

205. The design of the furniture of the Universal Exhibition has already been remarked upon at some length in illustrating the various principles laid down in the former part of this paper; and as there is a separate report on this division by Mr. M. D. Wyatt, it is unnecessary to enter upon it very fully here. Cabinet furniture.

206. France alone was largely represented in this section, and her display was naturally much fuller in Paris in 1855, than in London in 1851. There was, it is true, no sensible advance on the highest excellence achieved at that time, since Fourdinois, whose sideboard then held the place of honour, has merely rivalled, and not excelled his former labours, and other exhibitors, who have pressed onward towards excellence, though they have neared him in the race, cannot be judged to have surpassed what he has achieved. The other exhibitors of highly meritorious works were MM. Barbedienne, Grohé Brothers, Meynard and Fossey, Jeanselme, Cremer and Kreisser.

207. The prevailing styles of furniture were the Renaissance and the styles of the last century. Although the former, from its adherence to architectural arrangements, will ever find favour with the learned, who love precedent, even if it lacks utility; the latter, notwithstanding all their constructive errors, have more true originality, give Prevailing styles in France.

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more scope in the use of materials, and so great a variety that they will always retain their hold on the general public.

Over-decoration necessarily consequent on exhibitions.

208. It in some degree arises from the nature of the competition in these Exhibitions that works will be over-ornamented; yet, even with the allowance which is to be attributed to this cause, it must be stated that many pieces of furniture of rare skill destroyed themselves from the rivalry of their details; even when the ornament was carving only, it was frequently but too apparent that half the quantity would have had twice the effect. Moreover, although French carving is most skilful in its execution, and sometimes most beautiful in its arrangement, it often suffers, even in the best examples, from being too sharp and hard, and cut too clean and distinct from the ground. It would seem as if the studies for it were modelled on a hard surface, as slate or board, and not on a clay ground, which latter, if more difficult in the execution, gives that beautiful and tender interchange of relief which should ever be observed by the ornamental sculptor.

Faults of execution.

Faults of manner and style illustrated.

209. This is a little apparent even in the ornament of the beautiful cabinet of Fourdinois, now in the Museum of the Department of Art; in this work the wiry relief of the ornament contrasts with that of the panels; these are treated in the manner of Jean Gougon, and the low relief and delicate interchange of the form from the ground which he adopted has been followed. The rare excellence of this beautiful work will permit its being used as an illustration of faults arising from precedent. Under the authority thus derived the most misplaced ornamental details are often introduced. Such, for instance, as the broken pediment surmounting the cabinet, a treatment useless and merely ornamental in exterior architecture, and still more so in a piece of work of this kind. Of the same nature is the large ornamental pierced and enriched key-*stone* introduced in constructive *wood*-work, where there is literally no arch of which it is to form the key. These remarks are only made to point out faults inherent in a style which ignores the material, and applies indiscriminately to a wood construction the forms of a stone building. They may serve to indicate many errors of the like kind which in works of less merit lead to various enormities and incongruities.

On such works, art subservient to utility.

210. Another fault that has already been glanced at is the great impost or projection of the carved ornament in many of the most important pieces of furniture. It leads to great inconvenience, and to much sacrifice of utility, and would be entirely avoided by keeping the ornament, as it should

be, subservient to the constructive form, a source at the same time of real beauty and delicacy. It is also desirable to notice the extremely naturalistic carving, wherein the minutest details of plants and flowers, the feathers of birds, and the fur of animals are rendered with the most perfect skill by the carver. It should be recollected that when carving is to ornament a use, the carver should subordinate his art to its application, otherwise it is no longer ornament; we are called away to admire the individual details instead of the beauty of the ornamented whole.

211. No doubt a rigid adherence to this principle of sacrificing the parts to the whole effect would equally condemn the pictorially painted plaques inserted in Louis Seize furniture, and require an ornamental treatment instead, and we might have to regret a beauty in some sort arising out of error. Certainly the marquetrie pictures, such as the dog in his kennel, and the goat thrusting his head through a broken fence, where the attempt has been to give the most perfect pictorial imitation by means of marquetrie, would be condemned, and properly, if the above rule were carried out.

212. As a whole the exhibition of French furniture was very complete, and the ornamental workmanship of the highest character; at the same time there was little that was strikingly original in design, and nothing which was not referable to the past as the source of its inspiration.

213. English furniture was the next in importance to that of France, and, if small in quantity, was free from those gross impertinences which characterized this section in 1851. If less had been done, what was done was far more satisfactory, and had a character of its own, uniting excellence of manufacture with a large amount of tasteful design. The most important exhibitors were Messrs. Jackson and Graham, Messrs. Holland and Son, Messrs. Trollope, and Mr. Crace.

English furniture.

214. The cabinet and mirror exhibited by Messrs. Jackson and Graham has already been once or twice referred to, and the assistance derived from foreign and native talent pointed out. In the style adopted it certainly was one of the most remarkable, complete, and perfect specimens of taste and execution in the whole Exhibition, equally creditable to the manufacturers and the art-workmen, English and foreign, by whom they were assisted. The design was in good taste, rich, without being too florid. The mirror frame above the cabinet had one or two constructive faults, but it also showed some novel effects produced by reflexion in the mirror it enclosed, a source of increased enrichment

Great improvement since 1851.

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not often sufficiently studied by the designer. The carving and gilding of this frame was of a high order.

215. The larger work, exhibited by Messrs. Holland and Son, was a bookcase of a good substantial character. The carving was derived from natural objects, yet treated strictly as ornament, and not interfering with the structural lines, was good and suitable in its kind, although not aiming at much art; as a whole it was simple and in good taste. Their smaller cabinet, designed by Professor Semper, and executed in carved ebony, enriched also with China plaques painted by students at Marlborough House, is deserving of notice as a very successful attempt to introduce in England the variety of material and decorative enrichment that has been so successfully used in Italy and France. It laboured somewhat under the disadvantage of having been designed to embody the principal *plaque*, which had been previously completed, and which thereby became a little too important in its relation to the whole; but it was among the most successful works in the Exhibition. Much praise is also due to the simple style and unostentatious enrichment adopted by Messrs. Trollope in the furniture they exhibited, which was highly characteristic of English taste in such objects. Mr. Crace's principal work has already been spoken of.

Furniture of other countries.

216. From other countries the display of furniture was neither extensive nor excellent. Austria, so largely represented in 1851 by Leistler, sent to Paris on this occasion only some wood mosaics of a minute excellence; Belgium, a pulpit or two of average merit as to design; and Holland also a pulpit carved in a workmanlike style. Tuscany showed some pietra dura inlays of beautiful execution, but in bad taste, and some marquetrie work most skilful in its workmanship, but far too redundant in its ornamental application. Such work should be used as enrichment in panels or ornamental bands, and not cover the whole surface, or the work must appear tawdry and fatiguing to the eye. Ange Lombardi (169 Tuscany), exhibited some furniture carefully carved in the style adopted in the Barbetti cabinet exhibited in 1851, but hardly of equal merit. Some caskets and picture frames in the same style were also deserving of notice from the suitable character of relief adopted.

Porcelain, Pottery, Enamels, &c.

Porcelain and earthenware.

217. The next section of manufactures abounding with interesting comparisons is that of porcelain and earthenware, which was well represented in various countries, and especially in France and England. If in the former country

the great reputation of Sèvres has been maintained, and in some directions increased, since 1851, England has not only upheld the position she then won, but has rapidly advanced upon her rival, and in some instances even distanced her in the race of excellence.

218. We may pause to remark that the acknowledged reputation of the Royal manufactory, where works of the costliest character are designed by the ablest artists and executed by the most skilful workmen in the world, with the best models for their guidance, and unlimited means at command, permits of criticism without invidiousness, and enables an unreserved examination into the taste and principles of the ornamentation adopted; which, moreover, it is incumbent to make in order to the avoidance of errors inseparable from implicitly following great examples, since the faults of authority are apt to germinate, while the beauties may remain unfruitful.

Royal manufactory of Sèvres.

219. The position of the Royal manufactory in the present Exhibition is hardly due to its designers, for the *forms* of the objects exhibited, when not from old examples, cannot be said to be either fanciful or graceful, nor have they any striking novelty. But the high reputation of the manufactory has been upheld by the skilled artists and decorators, the talented sculptors, modellers, figure and flower painters, that have wrought there.

Faulty selection of form.

220. Thus one of the *tours de force* of the collection was a porcelain vase of the largest size, probably standing six feet high. The form was merely an enlargement of a common Indian shape, which, however suitable as a small jar, was clumsy, inelegant, and vulgar thus greatly magnified. It must ever be remembered that size has certain relations to beauty which cannot be overlooked if we would obtain a successful result, and it by no means follows that an object, agreeable on a small scale, will be equally agreeable on a large one also. Even in those exceptional works which come under the term "ornaments" there is a law of fitness which cannot be violated with impunity, and they must have that subordinate relation to other objects already enforced, or they will appear, as was the case with this jar, monstrous and distasteful.

221. A greater fault, however, arose from the body of the porcelain being of a sulphur-buff colour, which, conjoined with its size and the scattered and wiry nature of the floral decoration, made the object look much more like a gigantic specimen of common Birmingham japanned ware than what it really was, a costly piece of porcelain, and a specimen of extreme difficulty of manufacture.

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Necessity for adapting the decoration to the special material.

222. This is an instance of ill-selected form. There is another objectionable practice, which consists in the application of various modes of decoration, and even different materials to the same form. Thus a vase, originally designed for soft paste, with all the amenities of modelling, gilding, and colour which the Sèvres designers of the last century knew so well how to cumulate in their works, may be seen rendered into celadon, with merely the colour of the ground and the white reliefs to enrich a perhaps somewhat fantastic form. Or the classic form of the vase "la gloire," derived from the Etruscan, and adapted for unglazed bisque, becomes a celadon vase, with naturalistic flowers, quite contrary to Greek authority. Again, a majolica vase of the 17th century is treated indifferently as a faïence reproduction; or with the gay enrichments of the Louis Seize period, or in celadon. This must outrage the original spirit in which works were designed; and though such a practice may be overlooked in the general manufacturer, it is hardly compatible with the resources of such an establishment as Sèvres.

223. An illustration of faults which have partly arisen from not perceiving the necessity of adapting the ornamental decoration to the special material, and which are fostered by the practice just adverted to, may be drawn from the costly enamelled vase brought into the Exhibition towards its end. As this work was valued at 40,000 francs, it may well be supposed to embody the greatest excellence in design, the greatest skill in execution, as well as the most approved use of materials.

Errors arising from its neglect.

The vase was upright and oviform, somewhat the same shape as that purchased from Sèvres in 1851, and now in the Museum of the Department of Art. On the body of the vase were two oval spaces, on which were most beautifully and delicately coloured, on the one side Venus rising from the sea, and on the other Aurora scattering flowers. The body of the vase was enamelled of a very pale grey blue, which colour also formed the sky background of the figures. Between the ovals was a pale scrolled arabesque, terminating in flowers, from which issued grotesque figures. The scrolls were of a light pink, the flowers yellow, and the flesh of the grotesques blue; the whole colouring, besides being unpleasant and inharmonious, was so completely a porcelain treatment, that it wanted a somewhat careful inspection to satisfy one that it was not of this material. Yet this was not the case, it being really finely enamelled on metal; but the sense of the costlier and more difficult execution of enamel was merged in the

inferior one of China painting, from the adoption of a similar treatment of colour.

Enamel and porcelain distinct principles for decorating.

The old enamellers of Limoges were wiser in their colouring of the surface. They seemed ever to remember the metal beneath, and to give reference to it in the depth and scale of the colouring. This consisted predominantly of a deep metallic blue-black as a ground, on which cold colour rather predominated; and when flesh or other light and warm colours were used, it was comparatively in small quantities, and always as upon, and not as forming, the ground, which, however, told through to form the shadows. They thus produced a style which is at least totally different from any that has been applied to a porcelain body. In the one—porcelain—the body or material itself is beautiful, and its beauty allows it to be somewhat largely left as a ground, and the decoration only partially dispersed over it; in the other—the enamel—the ground is nought, and it requires to be totally hidden with rather a full treatment of colour. Thus light treatments of enamelled utensils are apt to liken them to porcelain, and a dark treatment of porcelain, where the whole ground is covered up, is likely to appear clumsy, heavy, and inelegant.

224. For this reason some clever imitative enamels, executed at Worcester, on porcelain with a deep blue ground, hardly made that impression which their meritorious execution should have claimed for them, and which they would have obtained had they been executed on metal.

225. There was another objection to the ornamentation of the Sèvres vase, which may be remarked upon before proceeding. It relates to its mounting. The vase stood upon a wreath of fruits, flowers, and leaves, enamelled with translucent enamel on gold. The pale porcelain-like body was surrounded by bands of gold and jewels; the spout and handles were enriched with masks in high relief enamelled the colour of nature. This treatment, so suitable and beautiful in delicate mounts of crystal or opal (as shown indeed in the cup exhibited by M. Duponchel), was common and tinsel-like when applied on a larger scale to the pale and washed-out looking ornament of the vase. It seemed unlikely that the richer material should have been really used to enhance one so apparently poor; and the vivid greens, reds, and purples of the transparent enamels were most incongruous and inharmonious in contrast with that of the body of the vase. In this instance, the very richness of the mounting prevented its full effect, like large jewels on an ill-conditioned wearer, which, even if real, are apt, from their very size, to be taken for paste.

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226. The most evident progress made at Sèvres was in the celadon ware; in this treatment of porcelain, a pale celadon green being used as the ground, the ornament, consisting of fruit, flowers, birds, animals, or figures, is modelled on it in extremely low relief, in a kind of white "slip" or enamel, the beauty of the work being greatly increased by the thinness of the enamel allowing the colour of the ground to appear through it in certain parts, in the manner of a cameo. By this delicate treatment the figures or objects are occasionally lost into the ground, and in other parts are relieved forcibly from it in a most artist-like manner. The details of the ornament, whether still life, animals, or foliage, are rendered with the greatest ease and felicity, and give evidence of direct reference to nature, and that the artist who designed has been the artist who also executed the subject, since the *once-ness*, spirit, and freedom of the work show that it has been committed to no second hand.

Sèvres celadon: its beauty,

227. A portion of a déjeûner service by J. Gély, now in the Museum of Marlborough House, is a beautiful and exquisitely finished example of this material. It presents some novelties for the study of our manufacturers in the interchange of celadon green and murrey colour, the latter forming the ground of cartouches or panels, on which subjects taken from fables are modelled with gem like beauty and completion.

and skilful modelling.

A large tazza or font surrounded by figures in the style of Jean Gougon, also at Marlborough House, will illustrate the power and spirit with which the higher class of these works are executed. It displays such talent in modelling the figure as rarely comes in aid of the manufacturer in the present day out of France. On another large tazza of the same character, Michael Angelesque figures painted in blue, in compartments alternating with the figures in relief, gave great vivacity to the work; but unfortunately this tazza had suffered in the firing. No works of this character are produced elsewhere competing with these, although some examples by French manufacturers are not without merit.

Painting on porcelain at Sèvres,

228. In pictorial art of a high class on porcelain, Sèvres stands also pre-eminent, and is without a rival. Many of the subjects are designed for this material by artists of great reputation; among others Hamon, with his classic taste and his power of entering into the spirit of child-life in old Greece; and Geromé, the author of the striking composition of the "Age of Augustus." The flowers of Jacobber and St. Jean are rendered on this beautiful material more

delicately even than they can be on canvass, and Ceimbert and Roussel have shown a talent that raises porcelain painting to the rank of fine art.

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its excellence.

229. The real difference between the porcelain painters of Sèvres and those of other countries seems to be that they are either educated artists who design and paint their own subjects, or who, when this is not the case, are able to translate the designs of others to the porcelain with almost the freedom of originality from the previous artistic power acquired, joined to a full knowledge of the material on which they labour. No artist out of France who *would* employ himself in manufacture could have produced the beautiful band of amorini which surrounded the celadon vase No. 303 in that collection, or the Michael Angelesque figures already spoken of; not because of the want of painter-like skill or artistic education elsewhere, but that the possessors of such talents, here at least, do not lend their aid to the manufacturers, and those educated for the purpose would render the work with the feeble timidity of copyists rather than with the free vigour of a master hand. The designs on some of the vases seemed like the spontaneous renderings of the first idea; where the artist, quite at home in the material, master of the technical execution, and revelling in the power of his brush, delights in producing his own thoughts on a material unrivalled for beauty, and returning the colour to the eye with the richest lustre.

Royal manufactory at Berlin.

230. In the porcelain of the Royal manufactory of Berlin the very reverse is apparent, the work, if original, has the cold propriety of a copy, and is too careful, too satisfactory, too laboriously good to be excellent. This, indeed, seems to be the case with a large proportion of German art workmanship; it has none of the *verve* in it of feeling, the artist seems never to have given way to an impulse, but is satisfied to be coldly correct and carefully impassive; in comparison with this frigid propriety, the wildest extravagance of French art is agreeable and fascinating.

And English china painting,

231. Too often also English painting on porcelain, as compared with that of France, has all the faults and timidity resulting from mere copying; not only are the best artists not employed to design for the manufacture, but those who are employed to paint on the material itself have none of the originality of genius, their labours may be correctly and unexceptionably rendered, but like step-children's tending, however judicious, the loving treatment of parentage is wanting, that true feeling of the artist which renders even faults more agreeable than tame correctness.

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232. It must not, however, be forgotten, that forty years ago the state of art at Sèvres had sunk from its former excellence to a still lower point, a frigid classicality had benumbed all originality, and a puerile minuteness of execution held the place of that artistic feeling and facile ease so admirable in the painting of the soft paste of old, and so visible in the modern works already spoken of. A small coffee service, made for the Duchess de Berri during the hundred days of the Restoration, now in the Museum of the Department of Art, will illustrate the state of art at that time, and by comparison with the works purchased at the Paris Exhibition, the rapid advance that has been since made.

The then painting at Sèvres was much like the present painting in the Berlin manufactory, of which, indeed, it seems to have been the parent.

compared with Sèvres.

233. English porcelain, as represented by the best works of Minton, is beyond the Sèvres of the restoration in artistic treatment, and infinitely beyond it in taste, as recurring to earlier and better periods of the establishment for models for imitation; such imitations are more skilfully rendered in our potteries than the Royal manufactory is even now able to attain to in soft paste, when excellence of "body," beauty of glaze, and sharp modelling of ornament are taken into consideration. It is only in the spirited painting of the subjects which decorate these works that a great superiority is evident at Sèvres, but this is obtained at an enormous cost—a cost which the private manufacturer could hardly hope to be returned, whatever may result from the prestige of a Royal manufactory. Moreover, the painting of flowers and figures on some of the English vases would bear comparison even with Sèvres, while the general manufacture of high class porcelain as dessert, breakfast, and tea services, were certainly superior in taste as well as in execution to the works of the same kind manufactured there, although of course derived from the same source—the earlier labours of this celebrated manufactory.

English earthenware unrivalled.

234. It was not, however, in the manufacture of porcelain alone, good and excellent as this was, that English pottery showed to such great advantage in the contest of nations; it was rather in earthenware, the beauty of which, even in our common goods, surprised the French people. Unaccustomed to any kind of faïence but of the simplest and most undecorated description, English earthenware seemed to them, from the excellence of its "body," the beauty of its forms, and the taste and care evident in its decoration, to approach so near to fine porcelain, that they were with difficulty persuaded that it was the inferior material. There

can be no doubt that the design applied to these goods has improved since 1851.

English majolica and Palissy ware.

235. Since 1851, moreover, a new art-manufacture has arisen, or rather an ancient art has been restored, and the majolica and Palissy ware exhibited by Messrs. Minton, called forth, as it indeed deserved, the admiration of our neighbours. Although in some few cases the works consisted of reproductions of old examples, (always varied however,) this was by no means general; large and massive pieces designed by Semper and Marochetti, and modelled by Jeannest and Carrier, gave novelty and freshness to the collection, which was well supported by works designed in the Government Schools of Art, and modelled and painted by the students under the able direction of Mr. Rice, Master of the School of Art in the Potteries, who also contributed some of the best original designs for the surface decoration of this material as well as for porcelain.

236. It is now quite evident that all that was formerly done by Palissy may be produced at present with equal if not greater excellence, and it is to be hoped that our manufacturers will continue to avoid such reproductions as the imitative Palissy by Avisseau and by Landais of Tours, truly clever although they are, and rather endeavour after originality connected with utility, than that which is merely ornamental. The Palissy dishes, with their imitations of fishes and reptiles in relief, were executed in his day as ornaments for the shelves of the buffet only; and while we can admire the energy and skill with which he overcame all the difficulties of an unknown manufacture, and the truth with which he imitated natural objects, we should regret to see mere copies of his labours, and trust to our designers striking out a new utility, and a new decorative treatment for the material which they have reconquered.

Mere copying of old examples reprobated.

237. This must be the case with majolica also, which, it is to be hoped, will not degenerate into the mere reproduction of old examples; there will be no progress to real excellence, until the designer of the ornament and the artist ornamenting are one and the same, and the facility of his hand aids the fulness of his mind in bestowing a ready wealth of beauty on the material.

238. In porcelain the material aids the painter's skill; it has a worthiness of its own moreover which adds somewhat even to the art, and well sustains an amount of care and conscientious *labour* on his part. But this is almost out of place in majolica; here the best effects are due to a facile and ready execution, the artist applies his art as it

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were condescendingly to the mean material, by a touch ennobling it, and thereby

> "Turning ——————————
> The meagre cloddy earth to glittering gold."

The least examination of the rare works which have been preserved to us from the 15th and 16th centuries will show this noble freedom, this untrammelled skill on the part of the artist. It is this for which our designers must first labour, and then be free. Great advance has, no doubt, already been made in the true direction, as was seen in the large vase and plateau exhibited by Messrs. Minton, at Paris, and in the card dish composed from the beautiful salver, by Baptista Franca, the property of Her Majesty; but to be really excellent, as the works of old, the artist must be equally free to wed at once the nobility of his art to the poor material which it is to enrich, and not be himself the timid slave of means. The old artist, in the wealth of his imagination and in the consciousness of his skill, was content to be often incorrect that he might be easy and original, and poured out, with a freedom that charms us, the beauties that he had stored in his fertile mind. The mere copyist tamely reproduces the errors as well as, or perhaps rather than, the beauties, and that which might be eloquent in the ready interchange of thought, becomes vapid and distasteful in the laboured copy.

As on the Florentine reproductions.

239. It is on this account that all the praise they deserve cannot be accorded to the excellent reproductions of Signor Freppa, of Florence, so excellent as almost to be deceptive. Signor Freppa has evidently done good service by his researches into the chemistry of the material and pigments, and as copies of old examples, the works are better executed than those of Messrs. Minton, but the latter have not been contented with mere reproductions; as has already been seen, they have made great and successful efforts to produce works of originality and beauty.

French faïence.

240. The display by Messrs. Minton aroused an emulative feeling at Sèvres, and during the period of the Exhibition some works in imitation of faïence were produced there characterised by the artistic talent which the Royal manufactory can at all times command. It is not unlikely that the friendly contest may be productive of increased attention to the material, especially as works of great merit have already been produced in France by M. Devers, both repetitions of old works, and large pictorial subjects prepared for the decoration of walls. Nor should the beautiful material nor tasteful ornamentation of the Nevers pottery exhibited

by M. Ristori be overlooked, of which choice specimens will also be found in the Museum of the Department of Art.

241. Another section, which must be classed under pottery, wherein England stood almost alone as a producer, and quite alone in excellence, was the plain and variegated tiles for pavements and wall decorations. There was, however, no special advance since 1851, although the show was new in France ; the same may be said of the Parian figures of Copeland, Minton, and others, which sufficiently maintained their reputation.

Neither is it necessary to enter further in to the excellences or defects observable in the general manufacture of pottery in France, since it is largely, and almost entirely, influenced by the works at Sèvres, and will, no doubt, be fully examined in the report on pottery ; it is sufficient to say that there is an evident advance in taste since 1851.

On Bronzes and Metal Work.

242. There is no section of industrial art, not even that of furniture, with its applications of carving, wherein the influence of fine art upon manufacture, and it may also be said the reciprocal influence of manufacture upon fine art, is more direct and perceptible than in works in bronze ; indeed, the greater number of such works (those classed as bronzes d'art) are really works of fine art reproduced in large numbers for general sale, and coming under the name of manufactures only from this multitudinous reproduction.

Intimate relation between fine art and manufacture in bronzes.

243. The skill, therefore, that is required in the workman must approach that of the original artist, at least in technical execution, and in the power of fully comprehending the details of his form and the intention of his labours. It is to be recollected that in almost all cases the *whole* surface of the metal, after it leaves the sand, is submitted to the chisel of the chaser, and that even in the mode adopted by Barye to remedy this evil, many joints have to be made, and their intersections, and the numerous *founts* to be cleared away, leaving but small real difference in the skill required at the workman's hand, however much more of the artist's own treatment of surface may be thus retained.

244. Thus it happens that in preparing these fine art bronzes for sale, a large amount of intelligent *finish* is demanded, of which finish, in works of art manufacture, as in works of art, there are various kinds and degrees. There is, for instance, first, the finish of the artist himself who originates the work, which, whatever the amount, is just so much as he considers conducive to its right and full

Intelligent finish requisite.

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expression; in the eyes of others, this may or may not be sufficient, but who shall add to it judiciously, add to it, and not remove some of its individual characteristics. Many would think the works of Michael Angelo very unfinished, yet could a touch be given to them which would not injure their completeness, since every touch has been a thought, every mark of the chisel cut with understanding and judgment. Very different in its character of finish, but still corresponding in its quality of artistic completion, is the noble shield by Vechte, exhibited by Hunt and Roskell. Here, again, the finish is the true rendering of the artists' feeling, neither more nor less; that execution which is peculiar to every original mind being apparent in every part, uninfluenced by the circumstance that in the eye of the many the work approaches nearer to what they consider true finish.

Nature of good reproductive *finish*.

245. Finish which results from the intervention of other hands than those of the original artist, is different from that already spoken of. It will be more or less perfect according to the knowledge and skill of the workman, but must of necessity be more timid, and less individual than that of the artist himself, always dwelling rather more on the perfection of parts than the general expression, and thus reducing the whole to a tamer uniformity. In fine art it is this discrepancy between the vigour of the thought and the painful care of the execution that frequently enables us to decide between a spurious copy and an original work. This careful and laborious rendering is what the world in general considers true finish, unable to appreciate the far higher excellence of that already spoken of, for in original works high finish is rarely accompanied by real genius, as may be seen in many painters of the Dutch school. When employed, however, on reproduced art, this finish will be careful, refined, and excellent, according to the education of the workmen. Such is the finish of the skilled bronzists of Paris, as exhibited in the best reproductions of Paillard, Denière, and Barbedienne; a finish which, while it is the result of knowledge, has rather more sleekness and prettiness than the bold and skilful handling of the fine old Florentine bronzes; such is the finish also of a large amount of the Parisian wood-carving; and of some of the China painting at Sèvres, although here the habit of rendering the designs of others in a different medium and on a different surface has given a certain amount of originality of hand even to those who are in some sense copyists. The easy access to public instruction in art, the numerous aids to art knowledge already spoken of, the high standard of *tradition* in the large workshops and manufac-

tories in Paris, together with the ready employment afforded to skilled labour, has raised the Parisian artizan as high in real power as he is in reputation, and has increased the appreciation of true excellence in the Parisian public also.

Finish without knowledge.

246. It must not be overlooked that there is another mode of finish in works of art—that where the workman executes without any acquaintance with the structure, and *tools* the surface irrespective of what it covers. A rote rendering which sees without knowledge and copies by mere imitation only, and so that the surface is smooth, the forms round, and the textures of hair or fabric laboriously manipulated, satisfies the workman, and too often the employer, even if fingers have a bone more or less in their phalanges, or the markings of tendon or muscle are wrought away. Such has, until lately, been too much the character of the *finish* that has prevailed in England; and even now where there is one that can arrive at true finish here, there are ten in France who are competent to undertake it.

Necessity for educating our workmen.

247. Now it is not with the desire to compete with or to attempt to disturb the bronze manufactures which are located in Paris, or, indeed, any other high class manufactures there carried on to the world's advantage, that we would urge the necessity of improving our English workmen up to the advancing taste and intelligence of the public, but it is necessary that this should be done if we are to continue to exercise with profit our own home manufactures. Our large manufacturers should therefore hold out every inducement to their workmen, and particularly to their apprentices, to avail themselves of the public instruction which is afforded, in order to their improvement in skill and taste, in their own specialty. In the Potteries, where an enlightened manufacturer has pursued this course, the result has been honour to the nation at large, and it is to be hoped a great advantage to himself; on the contrary, there are not wanting indications that in one of our great staple manufactures the demand for high class goods is entirely leaving a locality where the improvement of taste is neglected, to fix itself in other places where efforts have been made towards this desired end.

Influence of the bronze manufacture on French sculpture.

248. Except in so far as the completion of the individual work by the artificer is concerned, any remarks on the bronzes d'art of Paris would largely apply to the present school of Parisian sculpture, which otherwise than incidentally, and in its relation to manufacture, does not come within the scope of this report. There can be no doubt, however, of the marked influence of the general manufacture on the art, arising, perhaps, out of the relation thus

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directly established between the artist-sculptor, and the tastes, not of a narrow circle, such as in other countries are led to appreciate sculpture through a classic education, but of that wider circle of the Parisian public whom the manufacturer has to please as his general customers.

249. Hence it would be found that the Parisian sculptors have largely departed from the principles that govern classic art, leaving that treatment which may be called the *statuesque* they have rather adopted the *picturesque* as the basis of their art. Instead of the rigid laws of Greek art which proscribed even strong expression, and rather sought a dignified repose than action, there is a large body of French sculptors who have adopted a voluptuous and varied style, wherein action and expression play an important part; which, while it is akin to ornamental rather than to fine art, seeks at the same time to please the spectator less from æsthetic beauty of form than through the associations which the work calls up in the mind of the spectator—through the story rather than through the art. Of this nature are the figures by Duret, "the Neapolitan fisherman dancing the tarentella," or "the Italian husbandman improvising a comic tale," which are equally popular in the shape of small statuettes in bronze—for which, in fact, they seem more particularly designed—as in the original figures the size of life. Of this school also was the clever bronze lion snuffing at the dead carcase whose feet protrude through the sands of the desert which have been heaped over him. Such works, highly skilful and talented as they are, are rather of the *pendule* school, and introduce false taste into works of sculpture.

Intercourse between the artists and art-workmen.

250. But this more intimate connexion between the artist and the manufacturer, which tends to bring the artist into the workshop, and thereby into more close relations with the workmen, is no doubt a source of infinite improvement to the latter, by the higher intelligence he infuses into them, and the higher demands he makes upon their skill and knowledge. Such relations between artists and workmen are much more numerous in the workshops of Paris than in England, both in the sections of metal manufacture, furniture, porcelain, and tapestry, and no doubt tend to the excellence and skill which all acknowledge the French art workman to possess.

General metal work.

251. The design of the general metal work in bronze still follows the traditions of the last century, which are paramount in the French school. These works range themselves either under the masculine and massive metal scrollwork of Louis Quinze, bold, brassy, and with a certain magnificent

grandeur so well suited to display all the varieties of metal surface and all the enrichments which the workman can produce; or the more feminine delicacy, the bronze jewellery of the Gauthier school, with the tender chiselling which it requires for its completion.

The most prevailing styles.

While the Renaissance style is largely adopted in furniture, in works in bronze it is little used, and the Gothic still less so. In the Greek style some few designs of great merit and beautiful execution were exhibited by Barbedienne, as well as some metal treatments by the late M. Cahieux, which, with a certain degree of novelty, were Oriental in their general style. With the prevailing repetitions of the works of Louis XIV. and XVI., repetitions that add little of novelty, little that is not derived directly from old examples, there is a certain amount of that rendering of nature (already adverted to) which is pictorial rather than ornamental—a manner which copies nature's minutest details, such as the venation of leaves, the feathers of birds, and the hair of animals, rather than renders them ornamentally and simply—in the manner of the electrotype rather than with that selection which is the fundamental principle of art. The meanness which this mode induces is carried even into the art bronzes, in some of which far more attention is paid to the imitation of the ornaments and fringes of the draperies, to the minute tooling of chain-armour, of fur, and of the texture of garments, aided in many instances by varied tints of bronze, by silvering and gilding—than to those qualities which constitute true excellence in art—proportion, form, and composition. Compared with such works, the picturesque compositions, the rollicking satyrs, nymphs, and bacchanals of Clodion and Giradon must rank as high art.

Excessive enrichment.

252. The great fault in the French metal manufacture of this class is excess,—excess of elaboration, excess of burnishing or gilding or frosting, excess in quantity or in application. The repetitions of the designs of the former part of the last century, whether in pure metal-work, or in metal-work used as an enrichment of furniture, do not evidence *greater* skill than was possessed by the workmen of that age, but they do evidence *less* taste and propriety; and although that was a time when if ever "the lust of the eye" was to be satisfied, desire seems to have increased in the present day. Thus the furniture has more than its due share of or-molu, the bronze is too apt to be treated as gold. Bronze doré is the courtezan of art, too gaily dressed to be in pure taste; indeed it may be taken as a rule that riches in excess destroy our sense of richness; a jewel may be so large that we must presume it be false, especially unless supported by high

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dignity in the wearer, and gold or gilding so lavishly used that we may set it down for less than brass. The choice gifts of nature should be used sparingly to enrich by contrast, and not by quantity.

253. Part of a Renaissance dessert service (exhibited by Denière), in bronze doré, with enamels, glass, and jewels introduced, although too much loaded with enrichment, showed how eminently suited this style is for the service of the banquetting table, and for the union of fine art and ornament; but there were many instances of its application to utensils for the service of the church, where, from the same quality, its sensuousness, it seemed entirely out of place.

254. In an altar in bronze doré, designed by M. Questel, and executed by Poussielgue Rusand, for the church of St. Martin at Lyons, an early Romanesque treatment was reproduced with much felicity and true adherence to early precedents. That exhibited by Bachelet, from the designs of M. Viollet le Duc was less pure in style, and though resting on old traditions, had some of the more gaudy qualities of modern French art, arising somewhat out of a manufacturer's mode of cumulating enrichment by many repetitions of the same detail, rather than that by true variety which was always present in the old hand-work of this nature. M. Poussielgue Rusand exhibited two or three chalices in good taste, yet hardly equal to those of Hardman or Skidmore; at the same time, if we may judge from many indications, both in the way of chalices, patens, and monstrances, thoroughly rococo in their details—from the altar designed by M. Gault de St. Germains—from the extravagances of the Abbé Choyer—and more especially from the ecclesiastical vestments of Van Halle of Brussels, so costly, so gaudy, and so vulgar, the Church which sanctions such bad taste by its use, must be much fallen from the times when at least she was the patroness of all, and the producer of much, that was really excellent and pure in art.

of church furniture.

British metal-work ill represented.

255. There was little opportunity of comparing British taste and skill in this section of metal-working with that of France, since our manufacturers exhibited hardly any cast and chased work, and from Birmingham, the great seat of the manufacture, no stamped work of any importance was sent to Paris. It must, however, be owned that the design for such goods is largely derived from France, and that where chasing is necessary, the skill of our workmen is far below the average. It is pleasant, however, to be able to say with strict justice, that the delicate metal-work of the cabinet exhibited by Messrs. Jackson and Graham, executed,

as it is understood, by British workmen, was second to none in the Exhibition; a plain proof that only education and encouragement is required to render our art-workmen equal to any in the world. The chasing also of some of the bronzes of Messrs. Elkington indicate considerable progress to excellence.

Gold and Silversmiths' Work and Jewellery.

English goldsmiths work.

256. Continuing the examination of taste in design applied to manufactures, the next section coming under review consists of works in the precious metals—silversmiths' works—and plated goods—in which section France and England are, beyond measure, the largest contributors. While the superiority in art workmanship must still be, with one notable exception, conceded to French exhibitors, the greatest advance in general taste since 1851 has no doubt been made by England, who has obtained a footing of equality in this respect with her rival.

Influence of the Exhibition of 1851,

257. There was ample evidence that the display in Hyde Park had not been lost on our great firms, and that the best works there exhibited by Froment Meurice, Eck and Durand, Marrel, and Lebrun, had had their effect in subduing the too ornate and meretricious style of much of our massive plate; while the manufacturers of plated goods also had in their turn been influenced through these works and their effect on those of our own silversmiths. We have begun to see that art is more costly and rarer than mere bullion, and have produced works better in design and taste and more artistic in execution than at the former period.

on our great silversmiths.

258. This was seen in the display both of the Messrs. Hunt and Roskell, Hancock's and Garrard's, although the last has produced little novelty since 1851. The plate designed by Mr. A. Brown for the Goldsmith's Company will illustrate the more subdued taste of the general fabric; it showed good ornamental design and skilful execution; open, however, to the objection that the figures formed additions, rather than were composed as a part of the ornamental whole.

M. Vechte's shield.

259. The works exhibited by these firms were divisible into groups, vases, and other objects designed as racing cups, testimonials, and memorials, and treated more or less as works of art—and those objects of utility whereon the ornamental principle properly predominated. Prominent among those of the former class was the shield dedicated to Milton, Shakespeare, and Newton, the work of M. Antoine Vechte. This was exhibited by Messrs. Hunt and Roskell

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in an unfinished state in 1851, and even then commanded great attention and admiration; and now, completely finished, was no doubt by far the finest specimen of metal work in the Paris Exhibition, and the master-piece of modern times. It consisted of three principal compartments embossed and chased in silver, allegoric of the varied genius of the three great men to whom it is dedicated. A border containing subjects from Shakespear's Hamlet, Milton's Paradise Lost, and the Life of Newton, was most artistically *repoussé* in iron, and the spandrils or spaces between the subjects and the band, and elsewhere, filled in with grotesque arabesques in gold damasquenerie. The fancy and invention displayed throughout, the beautiful and varied relief, and the intimate knowledge of the human form, was supported by a thoroughly ornamental arrangement, and a perfect executive mode of treating the metals. Altogether this work was quite unrivalled, it did honour to the age and to the artist, as well as to Messrs. Hunt and Co., who had the boldness to cause its production. M. Vechte exhibited many other rare works, now and then a little too redundant, too overflowing with materials, but all of a high order of artistic merit.

Costly efforts on the part of manufacturers in the end repay themselves.

260. Allusion has before been made to the assistance which our manufacturers are so ready to seek at the hands of distinguished foreigners, and at the same time so prompt to acknowledge. Often this assistance is sought and obtained at a great present pecuniary sacrifice, as is most probably the case in this instance, and as it is known to be in many others. But in the end such liberality is sure to be repaid in the high character which it obtains for the firm, and beyond this in the instructive example such skilled labours hold out to all the assisting artists and artisans. Thus the cup designed and executed by Mr. Alfred Brown has much of the reflex of M. Vechte's art without in any degree being a copy, and bears ample evidence of how much the art of embossing silver has been stimulated and revived by the engagement of such high talent.

261. Mr. Hancock exhibited several works which will add to his reputation, one of the principal being a very spirited vase, embodying the meeting of Francis the First, and Henry the Eighth, at the Field of the Cloth of Gold. There was a largeness of manner about some of the figures of this work, and an executive skill that stood well, even in comparison with fine works already mentioned; and it is also pleasant to be able to say it was entirely the work of our countrymen. Another work, a tazza, exhibited by

Mr. Hancock, with a figure of Memory on the top, executed in *ronde bosse* by Mr. Armstead, was also an evidence of the great advance made since 1851. A group in silver of a hawk and hare, exhibited by Mr. Garrard, was a wonderful specimen of labour, imitated feather by feather and hair by hair, but if art is to keep in advance of galvano-plastic productions, it must be by largeness of style and artistic feeling, leaving these minutiæ wherein it is certain to be excelled by the other means. MR. REDGRAVE ON DESIGN AS APPLIED TO MANUFACTURES.

262. Prominent among the exhibitors in this section of metal work, was the firm of Messrs. Elkington and Co, whose galvano-plastic reproductions and electro-plated works stood alone for variety and excellence. These naturally divide themselves into trade goods, which are produced up to the standard of the purchaser, and wherein the florid metal treatments of the last century still in some degree prevail, (although even in these an advance in public taste is appreciable); and those art reproductions which appeal to a higher taste and, it is evident, to an increasing circle of purchasers. This beautiful art is so fitted for the dissemination of what is really good—which by its means can be given to the public at the same rate as more showy meretriciousness—that it deserves a careful selection for its application. Some well designed plated articles were exhibited by Messrs. Cartwright, Heron, and Co. Galvano-plastic reproductions.

263. It has already been said that France exhibits but little if any advance in silversmiths' work since 1851. The *chefs d'œuvre* of the various houses at that time are again exhibited as their master-works. Thus, the tea service of Messrs. Eck and Durand, exhibited in 1821, was again the show-work of the house; as was also the delicate little cup by M. Lebrun, which he has as yet matched by no new production. Messrs. Marrel are hardly so successful now as then, and the vase exhibited by them did not increase the reputation they acquired in the former exhibition. French silversmiths' work.

264. There is, however, one work of importance in this section which must not be overlooked, the dinner service executed for the Emperor by Messrs. Cristofle and Co., This work was a sort of modified revival of that style which prevailed during the first empire (a renaissance founded on Greek examples rather than on Roman details). This modified renaissance had all the frigidity of Greek ornament, with little of its real beauty, and remained but a short time in favour with the French nation; in the work above spoken of, while the ornament still retains some analogy to Greek forms, the details consist of natural objects, fruits, and leaves of fruit-bearing plants subdued to orna- Messrs. Cristofle's dinner service for the Emperor.

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mental treatments, and arranged symmetrically. It certainly is an improvement on what has been called the empire style, being more genial and far less frigid, while at the same time it is less redundant than what is usually called French renaissance: it looks a little chilly after the glitter of other metal-work. The ornamentation was generally a little too equal both in size, in quantity, and in relief, and consequently wanted contrast. The side plateaus consisted of figure subjects, in *ronde bosse*, representing Agriculture, Industry Sheep-tending, &c., the centre piece Fame distributing prizes from a globe, while Mars and Ceres depart each on their several missions of protection or culture; they were finely modelled and executed.

In addition to this service the firm exhibited some beautiful centre pieces of great merit in design and skill in execution. Nor should the application of enamel, both to silver and plated goods, by this firm be overlooked. Introduced in the form of bands and borders it had a novel and pleasing effect well worthy of the attention of our manufacturers, since it added richness and variety without being intrusive, or interfering with the outline of form.

French jewellery.

265. Jewellery, both that for the person and for the toilette, as well as those objects which being of a kindred nature come into this class; as, for instance, the mounting of rare stones, gems, crystals, and lapis as cups, or purely as ornaments, admits of freer scope for the fancy and skill of the artist than works of more strict and defined utility.

In these works the French have heretofore had, and still maintain a decided superiority for fanciful combinations and quaint inventions, together with great taste in the arrangement and setting of precious stones.

There is a different quality in their works, a lightness and ease as it were, which contrasts with those of England, where the jewellery is solid, substantial, and somewhat ponderous-looking in comparison, relying rather on mere bullion and precious stones than on finesse of workmanship, fancy, contrasted setting, or varied materials. Yet even in these qualities great progress has been made, and the collections of our three principal jewellers, already named together with that of Messrs. Watherson and Brogden, made a display on this occasion that, while it was of surpassing intrinsic value, was also of a high character for the artistic merit of the works it contained.

Madame Froment Meurice.

266. In France the most excellent works in fancy jewellery were exhibited by Madame Froment Meurice, who has revived a kind of cinque-cento treatment where gem

cutting and precious stones are united with enamels; these works contrast happily with the more modern styles. The principal jewels of this character were a bracelet with a large emerald engraved with a female head in high relief, set as the centre of a shield or cartouche, supported by angels beautifully wrought in enamel; and a brooch containing a finely cut cameo for the centre, mounted in gold and enamels, and surrounded by a group in coloured enamel of the birth of Venus, who is bursting forth from a shell, with tritons and nereids sporting in the water weeds that support it. One of these jewels, embodying the subject of St. George and the Dragon, together with several smaller pieces, are now in the museum of the Department of Art.

M. Rudolphi.

267. M. Rudolphi was also a large exhibitor in this section, and had adopted on this occasion a singular combination of materials giving a great diversity and originality to his works, although in some few cases they were more singular than pleasing. Many of the works by M. Rudolphi consisted of treatments combining lapis lazuli and oxydized silver, turquoise and ivory mounted in silver, and bloodstones and lapis in juxta-position. The effect was very singular, and the peculiar harmony obtained was somewhat analogous to the use of the minor scale in music, being a little sad and uniform, and in so far not well fitted for jewellery. There was, however, high merit in many of the works, the tankard of silver encrusted with ivory and turquoise, purchased by the Department of Art, is a good specimen of the style.

M. Jules Wiese also exhibited some jewellery of great merit and beauty.

Attempts at chryselephantine sculpture of doubtful success.

268. Before passing from this section it may be as well to offer a few remarks on the works in a species of chryselephantine art, which were exhibited by Madame Meurice. These consisted of two statues in carved ivory and silver, a Leda or Venus by Pradier and a Satyr by Feuchere, and which, together with a Minerva, life size, executed at great cost for the Duke de Luyores, and exhibited in the Palais des Beaux Arts, illustrate still further the tendency to a more intimate relation, already alluded to, between fine art and the higher crafts. It can hardly be said that the result was satisfactory, since both the sentiment of art and the materials used suffered by the union; the silver, whether as drapery, or as forming the animal portion of the figure of the satyr, did not appear silver, but had a common and pewter-like look, while there was such a want of union between it and the ivory that it was hardly possible to imagine them as one, or that the ivory passed beneath the

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drapery, or united to the metal used in the legs of the satyr. The jewellery also with which the smaller figures were enriched came more within the domain of the real than the other parts, and thus looked false and meretricious; even the ivory suffered, and had the appearance of a common material from the union, while the sentiment of the statue lost from the incongruity of the materials and the distraction they occasioned. These faults were increased through the draperies of the Venus, and the metallic portions of the satyr, being treated in too large a style for the nature of the work; there, if any where, a certain amount of tooling and texture would have been useful, and even a little incrustation or enamel might have been used with advantage in the drapery to carry one material, or the appearance of it, into the other. Moreover, the jewellery would have been better of silver, lapis, and turquoise, as that of M. Rudolphi, rather than of gold and rubies, which were adopted, and suited ill with the negative colours of the other materials. These works, together with some attempts to add colour to sculpture exhibited in the Beaux Arts, may assist in determining in the negative the question which has arisen as to the propriety of such treatments.

269. In false jewellery France made a great show, and displayed an amount of excellence, of curious workmanship, and of felicitous combinations of materials and art, whilst our Birmingham manufacturers, it is much to be regretted, sent no collection to prove the advance that is known to have been made in this direction.

Glass Utensils and Stained Glass.

Table-glass.

270. In the section of glass for the table—glass ornaments—and glass utensils wherein ornament is to be added to utility—France and Austria were the largest contributors, France seeming greatly to have advanced upon her rival since 1851 in skill and in design. Many of the effects heretofore most perfectly obtained by the Bohemian manufacturers are now successfully imitated and rivalled by France. The decoration obtained by flashing colourless glass with a coating of the same material coloured or opalized, and cutting through in various forms to produce the ornament, is at present productive of a very meretricious style, and seems to await the discovery of some new mode of treatment that shall avail itself properly of the means afforded by such beautiful materials. As it is, the whole manufacture rather produces ornamental toys in questionable taste, than what is really beautiful. Exception, however, must be made in favour of some of the cutting in the Bohemian

Instances of excellent cutting.

specimens; two glass cups, wherein a blue coating of glass had been partially removed so as to leave a cameo-like treatment of blue figures on a white ground, were remarkable specimens of artistic labour; and, when considered in reference to the price, were certainly unequalled in the Exhibition, these were bought for the Department of Art. In this section England can hardly be said to have exhibited either in white, in which her manufacturers are known to excel, or in flashed glass. A small number of objects however, in colourless glass, which were produced at the instance of F. Slade, Esq., ought not to be overlooked, since for perfect taste, for beauty of form, for the skill with which the known difficulties of manufacture were overcome, and for the refinement of the decoration, they were beyond anything we have yet seen in modern table-glass, and rivalled some of the choice specimens of the old Venetian workmen.

Messrs. Osler and Co. exhibited a large candelabrum in white glass, which, from the judicious treatment of the material in accordance with the law of prismatic forms, was much more effective than those of the Compagnie de Baccarat, in which the acanthus leaf was used as an ornamental element, giving a frosted appearance instead of those rich prismatic hues resulting from the other mode.

Stained and painted glass.

271. In stained and painted glass, many of the same names appear as exhibitors as in 1851, and often with great similarity in their works. France, England, and Belgium were the greatest contributors. In the former country, the strife still prevails between the mediæval principles of decoration and those which are purely pictorial. Thus, many of the works consisted of repetitions of twelfth century glass, wherein, while the lustre and richness of the period were sometimes successfully imitated, as in the glass by Alfred Gerenté, the faults were also in some cases reproduced as in that by Didron, whilst the repetitions by Lusson seemed to want fullness of colour in comparison. Hardman, in his three lancets of the history of our Lord, was the most successful in English glass of this kind; his windows, having the true principles for such works, flatness of treatment, with as little shadow as possible, translucency, and equal distribution of colour. But the great tendency in France (in which she is copied by Belgium) is to substitute the pictorial for the ornamental in the treatment of glass, a course fostered by the artistic skill of the glass painters, which renders them dissatisfied with the limits which the use of stained and painted glass places to the art which is applied to it. Forgetting this, the work is treated as a picture; expression and relief are achieved by elaborate stippling of

French and Belgian glass often pictorial.

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the flesh, the draperies are in large unbroken masses, and and the whole becomes rather a transparent picture than an ornamented window. One of the most successful artists in this manner is M. Maréchal, who was entrusted to paint the two subjects which filled up the arched ends of the roof of the Palace of Industry, as well as a smaller window over the principal entrance. Of the former, it may safely be said that their introduction was a mistake in taste. In the smaller work, heavy architectural scroll ornament imitated in relief surrounded a figure of Fame distributing wreaths to the victors, well drawn and cleverly executed, but quite contrary to the true principles of glass painting. This artist exhibited, in another part of the building, some well executed imitations of mediæval glass.

Silk, Cotton, and Woollen Fabrics, Printed or Woven.

Printed and woven hangings and garment fabrics.

272. The designs for French silk hangings have already been alluded to, and the executed works are generally of the same character; nothing can exceed the beauty of the dyes, the evident insight of the designer or putter on into the capabilities of the material and the manufacturing means, or the skill of the weaver; in these respects they are real lessons to us. But, when we consider the design as to appropriateness for uses, or as to any laws or decorative principles, it is impossible to approve of the great majority of the works displayed. In view of their extravagant obtrusiveness, it was a real repose to come upon a piece of hanging having the imperial emblem, the golden bee, powdered over its rich green ground, an evidence of subdued taste in high places that might at least be advantageously imitated.

Austrian hangings.

273. England exhibited but little in this section, and that little not calling for remark. Austria was a large contributor, the silk hangings and rich altar dressings of Hell of Vienna showed an improved taste since 1851, and except in delicacy of tint are fast rivalling those of France. Kostner, and Leeman and Sons, also of Vienna, exhibited hangings in good taste.

The influence of fashion in matters of taste.

274. The general design for garment fabrics is in France, and of course elsewhere, equally unrestrained by laws and unregulated by principles as the design for other fabrics or manufactures. Fashion, with all its extravagancies, here rules instead of a correct and cultivated taste; and, as fashion loves extremes, it often happens that the truth of to-day is the heresy of to-morrow. No doubt it is the duty of the manufacturer to watch the markets and to supply its

demands if he would increase his trade, yet between him and the designer will still rest a large share of blame, since they are ever ready to watch the coming mode, and if possible to be more fashionable than fashion. Exception may be taken perhaps as to whether it is right or wrong to weave imitative pictures of flowers and fruits on silk or wool, but there should be no hesitation in condemning what is extravagant and disfiguring to the person of the wearer.

275. Thus we find stripes so wide that they divide the breadth of silk into two parts, and which, in making up, will make the wearer's figure show of half one colour and half of the other. One season these stripes are perpendicular and following the natural flow of the drapery, but the next they are manufactured horizontally, so that every short woman must submit to appear much shorter by the caprices of this same tyrant fashion, while perhaps the next change will be to unite the two, and to destroy all the grace of form and line of fold by an enormous check. France is in some sort the Vanity Fair from which emanates these enormities; but it must be confessed that there is a grace in the doing, a finesse even in extravagance there, that is quite lost when these ultra-fashions are copied by other nations.

276. Beyond this, however, it is certain that the full value of the rich material and the beauty of graceful folds will never be obtained in garment fabrics until pictorial imitation is no longer considered as true ornament. What can be more practically absurd, and in these instances, bad in taste and false in colour, than the silk tissues of Silo & Co., —(France, 7123,) where a brilliant red ground of this delicate material was covered with bunches of grapes and apricots the size of nature, printed in imitation of the natural colours and enhanced with gold; or a deep blue ground covered with plums and pomegranates interspersed with golden ears of wheat; let any one compare in their mind such a treatment with the ornament-covered tissues of India, and consider which is in true taste, which is neat and beautiful and which tasteless and gaudy, and yet these are much less extravagant treatments than might be described even in woven goods.

Shawls.

277. Mention has already been made of some of the woven and printed shawls of the costliest kind which the Exhibition contains; it is much to be wished that the designers for these goods would abandon the Indian and Cashmere patterns altogether rather than change and vitiate their simplicity as is now too common; in these respects, however, the Glasgow and Paisley shawls are less objectionable than the French, some of them being in very

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good and restrained taste, as was the case also with some of those exhibited by Clabburn of Norwich.

278. It would serve very little purpose in this report to examine the design applied to printed fabrics, either woollen or cotton, since there is such an interchange between the countries that it is often difficult to determine the first source from which it proceeds; but there is no doubt that France produces a higher class of such goods than ourselves, and that a large body of our manufacturers profess to do no more than endeavour to supply the demands of the various markets without an attempt to lead them, and manufacture only for the masses and not for the cultivated few. The remark, however, may perhaps be permitted, that even with this intention and aim, it may be as possible to be below our market as to be above it—that it may even be possible to lead it and to increase it, by remarking those peculiarities which each country and each people require, and studying them relatively to nature's laws common to all the races of men. It is possible that the conditions thus arrived at may be fulfilled in harmony with these laws, better than in contravention of them, and that in the end a still larger constituency would be obtained by truth than by error.

True manner of studying the markets.

279. Thus if it be true that those we are apt to call barbarians, and generally all uncultivated people, have a strong sense of colour, it would doubtless be better to employ it according to the laws of colour, than in direct opposition to them, and at the same time in harmony with those known laws of form which regulate agreeable distribution rather than with lawless crudity, which is, perhaps, for the present accepted because no better can be obtained. There can be little doubt that uncultivated people require stronger and more pronounced patterns both as to form and colour than the cultivated races who choose those which are more delicate and refined; but there also can be little doubt to the philosophic mind, that this strength and these pronounced contrasts may be attained in harmony with the natural laws, and thus obtained, will delight even uncultivated tastes far more than when in opposition to these truths.

280. Moreover, it may be possible to presume too far that the customers in the great home market are as indifferent in matters of taste as the manufacturers themselves, until in the end these wake up to the fact that other towns, or perhaps even other countries, equalling them in skill, competing with them even in price, and far excelling them in design, have succeeded in driving them from their own

markets, and superseded them as manufacturers for the masses as well as for that superior few (the little leaven that leavens the whole mass) who are sure in the long run to influence the many.

PAPER HANGINGS.

Wall decoration and paper-hangings.

281. It is necessary to give a glance at this section of manufactures, although much that has previously been said will have applied to it. These works may in some respects be divided into two classes—paper-hangings proper—and pictorial decoration. As regards the first of these, the general principles are simple and obvious; large surfaces should always be quiet and unobtrusive, in order to maintain that breadth and repose which is requisite, and should only be much enriched at the borders and edges, as, for instance, in the mouldings of the cornice or dado—or, as was formerly the case, and is now again practised, by means of those borderings which are manufactured for the purpose. The patterns of paper-hangings, therefore, should be subdued, and proportioned to the size of rooms; the colour should be rather inclined to negative than positive, to tints or shades rather than to full hues, and should be so equally distributed as to avoid violent contrasts, which rule will apply to the forms also; these should be treated flat and not in imitative relief. These rules are necessary to be observed to render the walls a background, and subordinate them to the objects in the room, whether it be the furniture, the art, or the occupants themselves. In addition to this, there requires such a variety both for colour and pattern as will admit of a suitable choice for aspect or for situation, so as to carry out, or be in harmony with, the other furniture. These conditions observed, the ornament may consist either of abstract forms or of floral adaptations.

Pictorial decoration.

282. With regard to the second division—pictorial decoration, the more works are exclusively of this character—the more complicated and pictorial they are, the more unsuited they become for reproduction by machinery, and often the more distasteful when so produced. Too common at the best to be looked on with pleasure as works of art, they are impertinent and obtrusive in use, only fit for salons, cafés, and such places, where the meretricious supersedes the beautiful.

It is desirable that these works should be separated by a wide interval from the former, and that great care be taken that the pictorial principle of the one does not interfere with or supersede the strictly ornamental principle of the other, since they have, or should have, nothing in common.

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283 This, however, was not the case in French paper-hangings. The principal manufacturers, Messrs. Mader, Zuber, Délicourt, and Desfossé have each exhibited trials of skill in printing pictorial subjects by means of blocks; and rather neglected the more general manufacture. Some of these printed pictures were of a high order of merit, no expense had been spared in the first design, nor in the after processes of manufacture, and it is impossible not to admire the skill, however we may question the taste of such works. Thus one of the principal works by Desfossé was a rendering of a picture by Couture, the celebrated painter of the "Decadence des Romains." It was as clever as it was objectionable, both as to its principles of morality and of decoration. It represented the results of a masked ball: male and female figures (life size), in half naked and tipsy abandonment, were sleeping off the effects of their disgusting revelry.

284. Great enterprise has been shown in the production of these works, and there can be no doubt that the efforts required for their perfect execution has had a sensible influence in improving the other sections of the trade, and that the skill required to put these pictorial subjects on the blocks, to render the register perfect for the numerous printings, and, above all, the refinement and nicety in mixing the tints and harmonizing the colours, must qualify the workmen employed upon them in a high degree for the general manufacture, and tend to produce that superiority in these respects which characterises French papers; besides the high tradition of excellence achieved which is so valuable in the workshop, and which would make it worth the while of manufacturers in many cases to produce works of a high character irrespective of the market demand for them.

Its principle carried into paper-hanging.

285. But here the advantage ends, and the evil attendant upon the direction the French trade in paper-hangings has taken—an evil that pervaded all the works exhibited—must now be stated. There was evidently no distinction in the mind of the designers between the principles applicable or permissible in the one class of works, and those ornamental principles which alone should govern the other. Thus pictorial imitation was the rule throughout, not only pictorial renderings of flowers as ornament, but imitations of silk hangings with their plaited folds, of lace and muslin, of fringes, of stone and metal mouldings in high relief; but also, (even in high priced papers,) imitations of landscapes, birds, trees, and architecture, which would thus be multiplied interminably over the walls. Thus notwithstanding

the superior taste in the management of tints and the discrimination of colours, which is the result of the causes before alluded to, or of the better education of the French workmen, there was hardly a paper in good taste in the whole collection.

English paper-hangings.

286. In these as well as in many other respects the English paper-hangings showed to much advantage. It was evident that the inculcation of those laws which should govern the decoration of wall papers had made some impression on our manufacturers, who had moreover greatly improved in the mere processes of their trade. The forms were flat and well distributed, the tints better chosen than in 1851, and the works generally were suitable for their purpose, rich and full without being gaudy and violent. Those exhibited by Messrs. John Wollams and Co. bore comparison with the best class "paper-hangings" of France both for design, good taste, and execution; while the cheap machine papers by this house were without a rival in the exhibition, showing that works may be produced, ornamented in good taste, at prices that place them within reach of the poorest consumers.

CARPETS.

Carpets.

287. The subject of design for carpets has already had a large share of attention in this report, both in illustrating the principles of style and of ornamental decoration, and in examining the "designs" exhibited.

In France, notwithstanding the fancy and invention displayed in many of the designs applied to these fabrics, and the cleverness apparent in all, there is as yet no recognition of any distinct principles for their decoration.

Decorative principles for these fabrics,

It has been held, for instance, by those who have best considered the subject, that a flat treatment should be observed for that which covers the ground we tread on; and that the imitation of mouldings in relief, or even the pictorial imitation of flowers is improper in decorating such fabrics, while the representation of landscapes, sky, and water must be monstrous and out of place. Violent contrasts of form and colour have also been objected to as attracting the eye to the carpet, which should be entirely subordinate to the other furniture of the apartment. Therefore colour in rich low-toned masses, enlivened by abstract ornamental forms, or natural forms distributed equally over the surface and subdued as to contrast, would appear to be the true law for the designer.

as seen in the carpets from India.

288. This is entirely in accordance with the decorative principles observed in those beautiful fabrics from India,

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which in the present, as well as in the former Exhibition, were the object of such universal admiration for the richness and propriety they displayed. But in France it is quite evident that any principles are wholly disregarded, and that in spite of difficulties of manufacture, and of inappropriateness when manfactured—regardless of the intrusive and showy character which is sure to result from the neglect of the law of subordination—there is, on the contrary, in nine-tenths of the works exhibited, an effort to force the carpet into more than usual prominence, and to attract the eye to it by every possible strength of colour, boldness of relief, force of contrast, and extravagance in scale. In one work, a carpet woven in breadths, roses and poppies were measured two feet across the flower, which will serve to give some idea of the bold pretensiousness of such designs.

On floral ornaments for carpets.

289. It must not be inferred that, when the imitative treatment of flowers is objected to, the objection is intended in any degree to extend to the use of the forms and colours of flowers in the decoration of these or other fabrics, but simply to the pictorial rendering instead of the ornamental treatment which is required. In a late discussion on this subject at the Society of Arts, an eloquent speaker advocated the natural and "complete imitation of flowers," and, in objecting to their conventional treatment as ornament, said "He knew a most respectable and long established "firm engaged in carpet manufacture on an extensive scale "which conducted its business on the opposite principle. "He referred to the firm whose head partners—the months "of April and May—supplied a large part of the world "with green carpets, in which floral design was largely "introduced, and he believed generally to the satisfaction of "the public."

Nature requires art to fit it for man's uses.

It might, however, be urged in reply that the meadow-carpet of April and May would be but a dank and tangled maze for any but the rough foot of the labourer to tread did not art step in to render it truly a green sward carpet, to mow down its redundancy into the true velvet pile of our shaven lawns, from out of which the buttercups and the daisies, as they spring up to spangle it with fair and goodly ornament, are as much *displayed* as the most rigid conventionalist would require; for the ornamental law goes no further than to desire that the mode of representing the flower should be that which gives its truest form, its fairest colours unblotted by shade, and its most characteristic appearance, that indeed which it ever turns to the warm sun and the spectator's eye as he looks down upon it. A

treatment the more to be observed that it permits of the easiest re-production by the weaver's shuttle or the printer's block, while at the same time it also agrees with nature's great laws of growth and development.

French carpets.

290. It will be seen in the description of French carpets in the former part of the report that works of great pretension and of great cost were selected as examples of the taste in such fabrics, and so entirely does the taste of the general manufacture follow the style of those already spoken of, that it is really difficult to find a carpet which approaches to correct taste or one that is not wholly naturalistic in its treatment. One large carpet, however, in the style of the Renaissance, which had been fabricated by M. Braquienne for the Salon Louis XIV., at Baden Baden, was finely composed, and, allowing for relief treatment, was a most skilful design, beautiful for the arrangement of spaces and quantities, and for a rich and subdued quality of colour; a few such works would have redeemed the taste of French carpets, as it was it put to shame the pictorial treatments around it, and the colour and light and dark were so managed that the appearance of relief was not obtrusive. M. Salandrouze also exhibited one carpet original in its decorative treatment, and which had, therefore, some merit in its design; it represented a green lawn, over which roses and daisies were geometrically powdered with a simple and pleasing effect.

Improve in English taste in carpets.

291. In England the battle of principles has been fairly fought and is nearly won, for while our inventions for printing carpets, either in the piece or in the warp, have placed unlimited decorative means at the command of the manufacturers, there is evidence of a more restrained use of these means than formerly was seen even in woven carpets; these having at the same time been greatly and visibly improved in taste and in true principles of decoration.

292. No doubt there is still much florid excess and false taste in the carpets produced for the general market, more especially in those where the manufacturing process employed permits of a florid ornamentation as cheaply as a more restrained one, and which, therefore, appeal to the masses more than to the educated few. Yet even here a change is observable; take as an instance the printed carpets of Messrs. Bright and Co., they were certainly, as a whole, less gaudy and contrasted than the French, and with a truer sense of the harmonies of colour, the forms mostly arranged with some regard to symmetry and to scale of parts, although this probably arose from the mode of manufacture. A pattern composed of roses diapered over a marone ground, was almost in correct taste, bright and agreeable without

Restrained use of means.

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being obtrusive; and as, it is understood, this was one of the most successful in its general sale, it may be worthy of consideration whether a still greater conformity to principles in decorating these fabrics might not increase rather than diminish their marketable value.

293. Moreover, an advanced taste in the higher class of purchasers as to the ornamentation of carpets is to be inferred from the fact that designs essentially French in their character, when produced by English manufacturers, are subdued to a greater propriety in their hands. Such are some of those exhibited by Templeton and Co. and by Lapworth and Co., while many of the designs of the latter, as well as of those of Watson, Lowe, and Bell, of Harrison and Co., of Dixon and Co., and of Robinson of Welbeck-street, were of a very satisfactory character.

294. In Brussels carpets, the restraint on variety imposed by the limited colours at the command of the designer has, no doubt, been one cause of the more subdued character of their decoration; but this is not wholly the case, since in England these carpets are often designed in self-colours, in which less than the five obtainable tints are used; in France, on the contrary, hardly a carpet of this character was seen, the love of enrichment, even at the expense of propriety, being more prevalent.

Belgian, Prussian and Austrian carpets.

295. Many carpets, some of them of a most costly nature, were exhibited by Belgium as well as by Prussia and Austria, but no marked character, as contrasted with French design, was seen in them, except on the whole, a still greater extravagance in scale and in contrast of forms, more especially in the works of the Royal Manufactory at Tournay.

The rare excellence of the tapestries and carpets of the Imperial manufactories of France, and the beautiful works exhibited, have already been spoken of, and allusion made to the errors in principle which it is likely they have fostered.

296. There are many other classes of works and individual objects both in our own and other countries into which design entered, and which might well be remarked upon, were there not a fear that this report would be extended to too great a length. In some of these we excelled other countries in taste and skill, as for instance, in Papier Maché goods, in which Jennings and Bettridge were the best producers. In fire-grates and stoves, wherein nothing was shown equal to the tasteful works of Hoyle and Co. In imitations of woods and marbles, in which Moxon was unrivalled; and in the curious and tasteful

application of enamel to slate by Mr. Magnus. In others, we were either not exhibitors, or as yet have much to learn, and great room for improvement. In many of those cases, which are of necessity omitted, the works will have been already reviewed in other reports, while the object and scope of this has been to regard the question of design generally and in relation to principles rather than specially and individually, to take classes rather than particular objects and even to pass over classes where the principles that should govern the ornamentation of the fabrics are coincident with others already reviewed, or wherein there is no marked subject for discussion.

Decorative Arrangements within the Building.

Remarks on the decorative arrangements of the building.

297. It cannot, however, be out of place, before terminating this Report on Design, to record a few remarks on the decorative arrangements of the buiding devoted to the Industrial Exhibition and its contents, differing as these arrangements did in many respects from our own, and offering salient points for interesting comparison.

298. It is to be remembered that the building was not originally designed for the purpose to which it was thus devoted, and therefore any unsuitableness of the structure itself is hardly open to criticism; but it is necessary to allude to the great mistake made in not continuing the centre arch quite through from end to end, instead of returning the side arches across the end of the building. The centre arch terminating over the fronts of the gallery instead of behind, besides a bungling construction at the angles, shortened the apparent length of the whole building by about 150 feet. It was requisite to mention this to add how greatly the fault was aggravated by filling the ends of the arched vault with large masses of pictorial stained glass; the gigantic figures destroyed the scale of the building, and the vivid colour had still further effect in shortening the apparent space.

France had the experience of former exhibitions.

299. It is to be recollected that France had not only the experience of many former Exhibitions to guide her, but as respects the new adaptation of glass and iron had had the full opportunity afforded by the Crystal Palace of 1851, and its successor at Sydenham; and this not as to construction only, but also as to those arrangements within the building which had been crowned with success in 1851, as well as those which were to be avoided; thus starting from a point considerably in advance of our great National Exhibition.

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Utility the governing idea in 1851.

Ornamental arrangement the primary object in France.

300. Whatever success was apparent in Hyde Park was evidently obtained by taking, as far as possible, *utility* as the governing principle, leaving the artistic effects to be developed therefrom. Even the form of the structure itself arose out of utility—the enclosure of the largest amount of space by the simplest unit of form. Thus the whole may well be contrasted with the French building and its arrangements, where the principle adopted was that of considering the *ornamental effect* first, and making the utility, even the proper display of the merchandise, quite subordinate thereto. It is not always, however, that we can arrive at the beautiful by reasoning alone; some of the choicest effects are the result of apparent chance, and there is much of true genius in taking advantage of happy accidents and making them subservient to the end sought. But the French authorities, in the first instance, adopted a symmetrical arrangement of the goods and space, and endeavoured to enforce a rigid uniformity both as to the passages, which were to be straight and continuous, and as to the cases, which were to be, as far as possible, alike in size and height. This rigid symmetry, where it was really carried out—in the Lyons gallery and in the space beneath that gallery—was the cause of extreme monotony and a tiresome uniformity; the sense of size and quantity—of the immense—was quite destroyed by the absence of intricacy, besides the great want of light which it occasioned beneath the gallery.

Intricacy a great source of pleasure.

301. This quality of intricacy is a source of beauty which is inherent in our English landscape scenery from its roads and hedgerows, and has been adopted in our landscape gardening as a source of the picturesque. It was permanently present in our Great Exhibition from the liberty allowed to each individual to fill as they pleased the space allotted to them. This quality would have been totally wanting in the Universal Exhibition at Paris had the predetermined arrangements been completed and sufficient. But in the British space, and in part of that allotted to other foreign countries, it was fortunately overruled with the best results in the main building, while the pressure for space for late French applicants made it necessary to enclose the panorama, and unite the main building with the "Annexe," thus happily supplying accidentally what was wanting to the Exhibition as a whole, and totally destroying that uniformity which had in the first instance been prescribed *de rigueur*.

Ornamental Cases studied

302. Another great blot on the French arrangements in the principal building was also caused by unnecessary and

ill-considered regulations. The nave, the largest open space, and which should have been the finest feature of the Exhibition as viewed from the surrounding promenades in the spacious galleries, was perfectly disfigured by the large covered cases, carried out fully one-third towards the centre on each side of the nave, and from the covered cases enforced in the enclosed spaces between these large cases and the part under the galleries. This arrangement, adopted to increase the display by means of a number of highly ornamented cases instead of the only true display—the manufactures—was wholy abortive, and thus from the gallery, which should have allowed of the finest *coup d'œil* in the Exhibition, and whence the eye should have wandered from pile to pile of rich merchandise or skilled manufacture, it looked down only on the canvassed tops of cases, covered with the dust from countless feet, and the refuse which is sure to collect in all waste places from a careless multitude. This regulation, moreover, after being enforced on the English exhibitors, who were ready for the opening, was broken through by the French themselves, who were later in their arrangements. One of the few regulations in 1851, was to prohibit cases from protruding into the nave.

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rather than their contents.

303. Our neighbours are always happy in the abundance of plants which they employ to decorate the buildings for their fêtes and shows, and tasteful indeed is the skill they show on all occasions in improvising banks of flowers and flowing fountains to perfume and cool the air and carry nature into the domain of art. These made a prominent feature in various parts of the French Exhibition, and were a source of much beauty and pleasure. Exception must be taken, however, to the taste of the large fountain so prominently placed in the centre of the Annexe, which was formed to represent an enormous group of flowering plants, imitating nature on a gigantic scale in painted zinc, from the tips of the multitudinous petals, stamens, and leaves innumerable jets of water squirted like a continuous rain around. This fountain was an extreme and apt illustration of the false taste of naturalistic ornament, (the mere imitation of natural objects,) instead of a proper consideration of the utility to be decorated, and of the nature of the materials to be used.

Floral decoration of the Palais.

304. In conclusion it is necessary to express sincere regret that the pressure of other important duties and the great extent of the subject must have occasioned much to have been overlooked or only cursorily glanced at. The reports of Mr. Wallis and Mr. Digby Wyatt, both highly-qualified for the subjects they have undertaken, will, however, have necessarily supplied some of the shortcomings. Moreover

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the Report on Design in the Exhibition of 1851, went so completely over the same ground, that in many cases it seemed unnecessary to repeat the remarks then made, but rather to refer to that paper as supplementary to the present, and the one as reciprocally illustrating the other.

Concluding summary.

305. It may be permitted to me to sum up my remarks with the expression of a belief that the Paris Exhibition showed evidence of a great general progress in English manufactures towards good taste, and that if we are still behind France in this respect we are behind no other European nation.

306. Moreover, in those individual works, which, as being beyond the usual productions of the manufacturer, are the efforts which are to lead himself and others on the road to excellence, we are often quite on an equality with their best works. Meanwhile our Government, our manufacturers, and the public are awake to our deficiences, and all are on the alert to obtain that education for themselves and others which shall raise our national taste. France will do well to recollect that it is harder to maintain a reputation than to gain one, and should look with a zealous earnestness to correct those errors and signs of decadence which have been pointed out in a friendly spirit and with a full sense of what we owe to her teaching; they have in some sort arisen from the very high reputation that has rendered her fearless and lawless in matters of taste: *our* duty is to press forward and to be hopeful, remembering that not to advance is to retrograde, and that in this age of science and education it is somewhat of a reproach that there is a point, which our predecessors in past centuries reached, still far ahead of our own present position.

I have the honour, &c.

Richard Redgrave, R.A.,
Reporter on Design at the Great Exhibition of 1851.

Report on the Public Cost of the British Portion of the Paris Universal Exhibition, and on the Reductions in the French Tariff.

To the Right Hon the Lord Stanley of Alderley, President of the Board of Trade.

South Kensington,
1st January 1857.

My Lord,

Mr. Cole on the Public Cost of the British Portion.

1. In my first Report, submitted immediately after the close of the Paris Exhibition, it was not possible to place before your Lordship complete statements either of the cost of the British portion of the Exhibition,—as the accounts could not be closed at that early period,—or of the reductions in the French tariff which had been made, if not in consequence of the Paris Exhibition, at least concurrently with its progress. The requisite information having been obtained, I have now the honour of appending to the concluding volume of the Jurors' Reports some final remarks on both these topics.

2. As respects the public expenditure incurred in assisting British exhibitors to make a creditable representation of the resources of the United Kingdom and its Colonies, I have the satisfaction of stating that the hope I expressed that the expenses would not exhaust 40,000*l.* of the Parliamentary vote has been realized. The gross expenditure has indeed been 40,521*l.*, but as this amount includes a sum of 1,261*l.*, which are repayments for damages covered by insurance, for transit overpaid, and receipts for sales of catalogues, &c., the net expenditure of the Parliamentary vote has been only 39,259*l.* The estimate presented to the Treasury was 52,356*l.*, and 50,000*l.* were voted by Parliament, on the understanding that a rigid economy should be exercised. Throughout the whole progress of the work during three years, this understanding hasbeen always borne in mind, and the result is that more than 10,000*l.* of the Parliamentary vote will not be drawn upon.

3. In the Appendix (page 419), details are given of the receipts and analysis of the payments under the heads of the estimate, together with a statement of all payments exceeding 2*l.* made to every person employed. The mode in which the estimate was prepared, caused the repetition of some items, such as clerkship and stationery, because the estimate was divided under several heads, in order that the Treasury might determine if the whole or only portions of it should be recommended to Parliament for adoption.

MR. COLE, ON THE PUBLIC COST OF THE BRITISH PORTION.

4. It will be proper to explain why the detailed estimates for the transport of goods, and for the exhibition of the Fine Arts have been exceeded. In the case of transport, the excess arose from the much greater weight and number of the packages than could have been expected. The estimate had been based upon the best information that could be obtained of the cost of bringing over the French articles in 1851. They amounted to the number of 3,459, whilst the British packages reached the number of 6,319, and the weight of the latter was probably four times as much as the former, in consequence of the greater quantity of machinery in the British contributions. Moreover, the payment for the re-transport of goods not sold, had been left an open question when the estimate was formed. It is obvious that the authorities could not control the number or weight of the exhibitors' packages, even had it been desirable to do so. The other case of excess in a part of the estimate was the Fine Arts. Here the estimate was 5,055*l.*, and the net cost has been 5,829*l.*, after deducting 566*l.* paid for damages, but recovered from the insurances. In this case the excess arose chiefly from the great value of the works of Art sent, which was fixed by the proprietors who lent them, the insurances being made according to their own valuations. The total value of the works sent amounted to 137,560*l.*, and the amount paid for insurance, at rates varying from 50*s.* to 60*s.* per cent. reached the sum of 2,715*l.* On all the other nine heads of the estimate, it will be seen that the expenditure did not reach the amounts estimated.

5. Probably the best test of the economical administration of the British Exhibition will be furnished by a comparison of its cost with that of the French Exhibition in London. This has always been stated to have been 68,000*l.*, of which I am not aware that any details have ever been published. To render the comparison fair, the cost of the Fine Arts at Paris must be deducted, as there was no separate exhibition for pictures, &c. in London. Making this deduction, the cost to the public of the British Exhibition in Paris will have been under 34,000*l.*, or just half that of the Paris Exhibition in London to the French Government. And it should be borne in mind that in 1851 the number of French exhibitors was 1,710, and the space occupied was 44,993 superficial feet horizontal, as compared with 2,625 British and British Colonial exhibitors, occupying 75,439 superficial feet horizontal, in 1855; whilst the weight, bulk, and number of the British goods sent to Paris greatly exceeded those of the French goods sent to London, as already explained. A great source of economy in the British expenditure was the moderate cost of the British staff in Paris as compared with that of the French staff in London.

Mr. Cole on the Public Cost of the British Portion.

6. The publication of the concluding parts of the Reports of the Jurors now issued, completes the work of the Paris Exhibition. In my first Report (page 28) I pointed out that the utility of such reports would have been greatly increased had they been published whilst the Exhibition was open, and I am strongly confirmed in the opinion, that should the Government cause any reports to be prepared in future Exhibitions, measures should be organized at an early period to insure the publication of them as soon as possible after the opening of the Exhibition.

7. With this view, the subjects of the Exhibition should be properly divided and given to a sufficient number of reporters possessing scientific and technical knowledge. The minute classification prepared in 1851, would aid the proper allocation of subjects. I conceive that at least a hundred reporters would be necessary, in order to treat the subjects in a really practical manner. As far as possible it would be desirable that these reporters should be recommended to the Government by chambers of commerce, and trade and scientific associations. The travelling and personal expenses of the reporters being paid, say at the usual rate of 1*l.* a day, and the manuscript reports at the rate of payment allowed by the Quarterly Reviews, I apprehend there would be no difficulty whatever in obtaining the assistance of competent persons in their preparation, and that the cost would be about the amount which has been incurred in the present instance.

8. The reports should be obtained from the reporters within four weeks after the opening of the Exhibition, and allowing a fortnight for the printing of them, they would thus be in the hands of visitors, to be used whilst the Exhibition was open. The want of such guides as these reports would be, was felt strongly in 1851, and again in Paris, although it was partly remedied by the preparation of short notes, which were circulated during the Exhibition. Several incidental advantages would be gained in the publication of the reports at an early stage of the Exhibition. A motive would be given to exhibitors to be punctual in bringing their articles, and to have their arrangements completed by a fixed time; there would also be an inducement to exhibitors to be present themselves during the short time allowed for the preparation of the reports, and thus be able to afford to the reporters explanations of their contributions.

9. The past system, which allowed any latitude of time for the preparation of the reports,—the whole of the French Reports in 1851 not being yet published, and none having yet appeared for the Paris Exhibition of 1855,—gave no encouragement for punctuality.

Mr. Cole on the Reductions in the French Tariff.

Before concluding this report there remains the subject of THE REDUCTIONS IN THE FRENCH TARIFF, on which a few remarks may be offered.

10. The influence of the International Exhibition of Paris in modifying the French tariff has been marked. The Exhibition certainly has been the means at least of opening the channels of a mutual commerce between the two countries, the extent and consequence of which cannot be measured; and probably no other mode of attacking successfully an obstinate prohibitive system could have been devised, to which the French mind would have submitted so readily and so patiently.

11. On the occasion of the Exhibition itself prohibition was absolutely abolished, and from the period when the Exhibition was first announced, in 1853, there has been a succession of important changes in the French tariff, all of which have tended to promote a much freer interchange of productions between the two countries than was possible under the former system. The reductions which have taken place between 1853 and the present time are detailed in the Appendix (p. 433). Already they are calculated to be of mutual benefit to the two countries, and affect above 300 articles. On some articles an absolutely free trade is permitted. On iron in various forms, the reduction will be found to vary from 36 to 69 per cent. In machinery the reductions have varied from 16 to 40 per cent., the largest reduction being on agricultural machinery. During the period that these reductions have been in progress an immense increase has taken place in our export trade with France. From information given in the *Economist* (1856, pp. 983–4.), it appears that between the years 1840 and 1853, on an average of those years at each extreme, there had been only an increase of 1 per cent., whilst in 1854, the first year after the Paris Exhibition had been announced, and great changes had been commenced, there was an increase of 23 per cent. over the preceding year; and in 1855 the increase over 1854 actually reached nearly 90 per cent. It has been estimated that the French *Douane* has been benefited by an increase of as much as 2,000,000*l.* since 1853. Great as these results are, many greater are, doubtless, in store, as very many articles, especially manufactures, still remain prohibited in France. But it is clear that the French government purpose to give France the benefits of a free trade as soon as may be practicable; and, connected with the reductions already made, it will not be out of place to preserve a record of the proceedings which have thus far taken place to realize it. In the last legislative session a measure was prepared by the government for the purpose of getting rid of prohibition altogether, and substi-

tuting certain duties. A copy of this *projet de loi* is given in the Appendix (B.) The project, according to expectation, was strongly opposed by certain interests in France, and the session closed without adopting the changes. The French government then named a commission to report upon the presumed effect of the proposed changes on French industry, and subsequently it has been announced that prohibition will absolutely cease in 1861. Certainly no causes will have been so influential in producing this result as the two international Exhibitions of 1851 and 1855.

12. Whilst it can hardly be questioned that an increased interchange of their respective productions between France and England would be a result at once highly beneficial to both countries, it may be worth while, at the same time, to inquire if international exhibitions have a tendency to benefit, in an equal degree, the manufacturing position of all countries, as well those which are in advance as those in the rear of the others. It is, perhaps, too early to be able to produce any very conclusive evidence bearing upon this question; but, in the front of such an inquiry, it may be asked, *Can* publicity, which is *the* chief characteristic of such exhibitions, be injurious to any party?

13. It should be remarked that, with the daily increasing means of transport by steam ships on sea and railways on land, instant communication by means of the electric telegraph, and freedom of correspondence by cheap postage and newspapers, measures almost wholly originating in this country, the knowledge of the industrial and natural products of nations *must* extend, even without the especial stimulus of international exhibitions, which, indeed, seem to be merely the complement of other agencies at work independently of them.

14. Publicity itself, with its attendant free discussion and knowledge, is the mainspring of all the progressive tendencies of the present age. Publicity in commerce and manufactures is in direct contrast and antagonism to the "mysteries" which prevailed in the middle ages in all industrial crafts, but which are now practically impossible. Exhibitions make the acquirement of this knowledge all the easier, more emphatic and palpable, but the knowledge itself may be obtained without them. There is nothing to prevent any Russian from buying and copying the best cotton machinery made in England, or to prohibit any country from obtaining Whitworth's standard gauges; and, as a general rule, our most advanced manufactories and workshops are open to the fullest examination of all foreigners. As knowledge becomes complete and accurate, so must human action in all its bearings approach perfectibility,

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but it is impossible to conceive that works of human industry will ever arrive at a stage when they cannot be improved.

15. An extended knowledge of the nature and capacities of production peculiar to each country is the first and most obvious result of international exhibitions. This knowledge is spread not merely from nation to nation, but most usefully between the producer and consumer, establishing a direct connexion between the two, especially in those articles retailed in small quantities, which are oftentimes not known at all to the consumer. The consumer who goes only to the retailer's shop is practically limited by the distributor in his choice of articles, and it is notorious that in many departments of trade, the producer has hitherto had much reason to complain of the ignorance and prejudice of the distributor. The universal complaint among producers of the highest class of fabrics has been of their inability to bring them before the public. Messrs. Titus Salt & Co. sent to the Paris Exhibition some of their woven mixtures of silk and alpaca in the hope that they would attract an amount of public attention from *English* visitors, which would induce the home retail shopkeepers to keep them. The cotton printers feel themselves very much under the practical dictation of the buyers. It was years before the manufacturers of Parian could induce the shopkeepers to keep Parian statuettes, which have now become common in all shop windows. The effect of exhibitions has been to introduce the consumer to a much wider acquaintance with the things produced, to enlarge the boundaries of his choice, and, consequently, to encourage the producer in new efforts, and render him more independent of the middleman. Every producer of any eminence whom I have consulted agrees that the London Exhibition has been of signal advantage to him in this respect; and it is also satisfactory to know that whilst these extended relations have arisen between the consumer and the producer, the retailer has had no reason to complain of the result to himself. His business has increased by the public demand for articles which he had feared to incur the risk of ordering.

16. A most unusual rate of increase in almost all kinds of production in the United Kingdom has taken place since the Exhibition of 1851. The exports have risen from 71,367,000*l.* in the year 1850, to 95,568,800*l.* in the year 1855, and to 105,845,000*l.* for only eleven months of 1856. Here is proof how great the interchange of productions between other nations and ourselves must have been. It is obviously impossible to say how much of this increase may be attributed to the two International Exhibitions, but so far as evidence has been sought for from individual exhibitors, each has been

able to trace an increase of his business to causes arising from these Exhibitions.

Mr. Cole on the Reductions in the French Tariff.

17. The publicity occasioned by them is admitted to have been highly useful in making known the resources of the East Indies and most of our colonies, particularly Canada and Australia. The only exception I know of is Malta, which is stated to have derived no advantage from the Exhibition of 1851, and did not exhibit in Paris. The advantages to the United Kingdom and the colonies must have been wholly unmixed and reciprocal. It has, probably, been the same with the United States, and even such countries as Spain and Turkey. It certainly cannot be affirmed that the national industry has suffered up to the present time from international exhibitions, nor are there any prospects that it will be likely to do so in future.

18. As respects foreign countries, France and Germany especially, they have seen and bought our productions, and particularly our machinery. Are we likely to be damnified? It will be curious to watch the effect of the introduction of our agricultural machines into France. The tariff now permits our makers to export them to France. Doubtless, France will manufacture for itself such machinery hereafter much more extensively;—at the same time is it not likely that a trade will be created between France and England which did not exist before? Is the effect in the sale of other kinds of machinery likely to be different? Shall we only have taught other nations to be our competitors in the world's markets? Foreigners bought samples of our machinery in Paris because it was a cheaper and better article than they made.

19. Besides the actual sales made and the formation of new connexions, the English machine-maker learnt the relative status which foreign machinery had obtained, and certainly the effect of this knowledge appeared in every direction to stimulate the desire among our manufacturers to maintain the superiority which they already possessed. This symptom is a most healthy sign for future progress.

20. There is no evidence to prove that any superiority in respect of general quality or price which British manufacturers showed in the London Exhibition of 1851 had been either relatively or positively lost in 1855, whilst in several kinds of manufactures which demand appropriateness of decoration, a very palpable advance was acknowledged on all sides to have been made. Still it must be allowed that the interval is too short to trace any but very marked results.

21. It would seem that any influence which international exhibitions may exert on manufacturing industry must be

MR. COLE ON THE REDUCTIONS IN THE FRENCH TARIFF.

comparatively trifling, when balanced against the natural resources, the climate, the geographical position, and the character of the people of a country. So long as the United Kingdom enjoys its present advantages in possessing great mineral resources as well as those facilities of transport which arise from its insular position, and the physical energy of its people does not decline, it would seem to follow that no result but a highly beneficial one would ensue from that extended publicity of its productions which is conferred by these exhibitions.

22. Looking to the particular circumstances of France, the commercial tendencies of the two countries would seem to promise much less actual competition in like productions than the increased exchange of different productions peculiar to each country. Whilst we export our iron and coal to France, she in return might send to us her wines, silks, and all kinds of articles connected with the luxuries of civilized life. It is as unlikely as it would be fruitless that the two countries should struggle to change the natural tendencies of their productive powers.

23. International exhibitions will extend and hasten the development of the productive industry of all nations, but they are not likely to counteract those natural laws which are regulated by the climate, the physical condition, and even the political institutions of each. Almost every nation has something peculiar to itself which is useful to another, and it is the increased ease of interchange which international exhibitions chiefly promote.

24. Looking to their influence on this country, international exhibitions may be said to have been of eminent use. They have created both an earnest wish for the better education of all classes, and even perhaps an exaggerated dread of being outdone by other countries, but at the same time a firm resolution to advance. Almost every branch of national industry has shown progressive improvement since 1851. And notwithstanding greatly increased taxation, the general commerce of the kingdom has made enormous strides since that year, which, in some measure, ought to be attributed to the two international exhibitions which have taken place. It seems, therefore, to be a conclusion which cannot be gainsaid, that these Exhibitions have both amply repaid the United Kingdom for the exertions and outlay which have been made.

I have the honour, &c.

HENRY COLE.

APPENDICES (A, B, C,) TO MR. COLE'S CONCLUDING REPORT.

APPENDIX (A.)

ACCOUNTS OF THE PARIS EXHIBITION.

I.—Comparative Statement of Expenditure with Vote of 50,000*l.*
II.—General Statement of Receipts and Payments.
III.—Alphabetical List of Accounts.
IV.—Payments for Personal Services, Executive Staff, and occasional Services.
V.—Payments to Jurors.

I.—Comparative Statement of Expenditure with the Vote of 50,000*l.*

Heads of Service according to Estimate.	Total Payments.			Total Estimate.
	£	*s.*	*d.*	£
1. Expenses of preliminary Arrangements in England	3,171	6	3	3,700
2. Freight and Carriage of Goods, Customs Charges, &c.	7,587	18	9	2,750
3. Office-management in Paris	3,282	3	7	3,375
4. Completion and General Decoration of the British Department of the Exhibition	3,984	12	2	5,000
5. Maintenance, Cleaning, and Watching	3,446	0	6	5,200
6. Removing and Warehousing Packing Cases	943	10	2	1,500
7. Printing, Advertising, Postage, Stationery, and Extra Clerks	1,382	10	4	3,800
8. Securing a proper representation of Raw Material and Scientific Apparatus	2,066	15	8	2,000
9. Expenses connected with the Division of the Fine Arts	6,476	17	6	5,055
10. Services and Expenses of Jurors and preparation and printing of their Reports	4,165	9	8	11,250
11. General Contingencies	4,014	7	10	6,370
Totals	40,521	12	5	50,000

Note.—*The greater part of "Printing, Advertising, &c." is included in Preliminary Arrangements in No.* 1.

Total Payments	£40,521	12	5
Deduct repayments, and gain in Exchange.	1,261	12	9
	£39,259	19	8

John J. Mayo, *Superintendent of Accounts.*
W. Matchwick, *Financial Clerk.*

II.—General Statement of Receipts and Payments from June 1853 to January 1857.

Receipts.	£	s.	d.	Payments.	£	s.	d.
1. By account of vote of 50,000*l.*	39,450	0	0	As per heads of Estimate (I.)	40,521	12	5
2. Interest and gain on exchange	96	12	1				
Repayments.							
3. Insurance for damages	566	3	8				
4. Cloth, materials, catalogues	384	18	6				
5. For transport	213	13	6				
	1,165	0	8	Balance in hand	190	0	4
	40,711	12	9		40,711	12	9

III.—Alphabetical List of Payments of £5 and upwards.

Note.—In rendering French payments into English currency the exchange has been taken at 25 Francs to the Pound Sterling.

	—		—		Total.		
	Fr.	*c.*	£	*s.* *d.*	£	*s.*	*d.*
Airey, G. B.: Charges for Greenwich model and apparatus	.	.	.	.	452	12	11
Asprey, Charles: Desks, portfolios, &c.	.	.	.	.	47	15	6
Atlee, Falconer: Fittings of offices	.	.	.	.	10	2	7
Arthur, M. and Son: House agency charges	.	.	.	.	13	0	0
Bull, W.: Carriage of cases (coal collection)	.	.	.	.	6	0	0
Brooks, Vincent: Lithography	.	.	.	.	96	11	0
Becker C.: Repairing scientific apparatus	.	.	.	.	5	16	6
Barclay, George: Printing placards	.	.	.	.	9	12	0
Bell, J. A.: Packing cases for fine arts	.	.	.	.	5	12	6
Bingham, R. J.: Photographs of Exhibition arrangements	.	.	.	.	72	5	10
Burch, Joseph: Freight of goods	.	.	.	.	5	4	2
Boyard, M.: Rent of offices in Paris	15,000	0					
Taxes of do.	1,219	54					
Damage to do.	122	65					
	16,342	19	.	.	653	13	10

III. Alphabetical List of Payments—*continued.*

	—		—			Total.		
	Fr.	*c.*	£	*s.*	*d.*	£	*s.*	*d.*
Blatrier M.:								
Packing cases and packing	831	50	.	.		33	5	2
Clowes and Son:								
Printing for 1854–56	.	.	.	.		1,157	15	0
Cameron, Captain, R. E.:								
Carriage of Ordnance instruments	.	.	.	.		12	3	8
Cockerell, C. R., R.A.:								
Packing cases for drawings	.	.	.	.		7	7	3
Crépeaux, M.:								
Labour in garden of Paris offices	163	0	.	.		6	10	5
Cappe, E.:								
Labour and materials for completion and decoration	5,074	45	.	.		202	19	7
Clech and Deroche:								
Glass bottles for agricultural collection	1,187	50	.	.		47	10	0
Chamouillet, M.:								
Glass cases, shades, &c.	1,118	25						
Sundry works of fittings	110	0						
	1,228	25	.	.		49	2	7
Chadelat, F.:								
Firing for Paris offices	1,359	30	.	.		54	7	5
Camus, M.:								
Loan of trucks, &c.	150	0	.	.		6	0	0
Chenue, M.:								
Packing cases and packing	992	75	.	.		39	14	2
Delizy, A.:								
Translations	.	.	.	.		10	10	0
Day and Son:								
Lithography	.	.	.	.		6	0	0
De la Rue, T., and Co.:								
Number tickets, price labels, &c.	.	.	40	6	10			
Class and divisional labels and tickets	.	.	177	9	0			
	.	.	1	19	0			
						219	14	10
Daniell, R. P.:								
Freight paid in error	.	.	.	.		5	0	0
Dent, Frederick:								
Watch	.	.	.	.		26	5	0
Durham, J.:								
Damage to work of art	.	.	.	.		9	0	0
Duchatel, A.:								
Green serge, cloth, &c.	254	90	.	.		10	3	11
Dubreuil and Co.:								
Labour and materials	2,823	37	.	.		112	18	9
Delarue, E.:								
Stationery in Paris	610	95	.	.		24	8	9
Depetiteville, M.:								
Divans, seats, &c.	453	0	.	.		18	2	5
Desachy, A.:								
Labour and materials	1,380	0	.	.		55	4	0
Dupont, P.:								
Printing press in Paris	335	0	.	.		13	8	0
Disderi, M.:								
Photographs of the Exhibition	866	0	.	.		34	12	10

III. Alphabetical List of Payments—*continued.*

	—	—	Total.
	Fr. *c.*	£ *s.* *d.*	£ *s.* *d.*
Dowson, J. E.:			
Canvas, &c.	. .	. .	10 4 0
Doyle, J. V.:			
Newspapers	. .	. .	12 18 4
D'Yenne, M.:			
Law charges	. .	. .	43 4 8
Elkington, Mason, and Co.:			
Specimens of electrotyping	. .	. .	90 4 9
Elliot Brothers:			
Mathematical instruments	. .	. .	20 5 0
Earle, Thomas:			
Damage to work of art	. .	. .	10 0 0
Edgington, Benjamin:			
Flags, blocks, &c.	. .	. .	54 17 1
Eynaud, M.:			
Rent of "Hangar" for packing cases	12,000 0	. .	480 0 0
Elce, J. and Co.:			
Repairs of machinery	187 50	. .	7 10 0
Freeman, Charles:			
Surveyor's expenses for report on security of Fine Art building	. .	. .	68 5 0
Fairbairn, W. and Sons:			
Wear and tear of working steam engine.	. .	. .	100 0 0
Franchi, G.:			
Repairing damaged model	. .	. .	30 0 0
Foley, J. H.:			
Damage to work of art	. .	. .	16 0 0
Ferrey, Benjamin:			
Damage to work of art	. .	. .	17 0 0
Firmin, Didot, and Cie.:			
Printing of French classification	547 80	. .	21 18 3
Fortin, M.:			
Stationery in Paris	891 38	. .	35 13 1
Gassiot, J. P.:			
Philosophical apparatus	. .	. .	202 7 11
Green, Joseph:			
Collecting and packing works of art	. .	. .	975 19 9
Garrard, R. and S.:			
Cost of repair, &c., racing cups, lent for decoration	. .	. .	46 9 9
Grundy, R. H.:			
Packing cases, &c. for pictures	. .	. .	5 15 0
Grundy, J. C.:			
Packing cases, &c. for pictures	. .	. .	16 4 6
Giles, J. W.:			
Damage to work of art	. .	. .	10 10 0
George, M.:			
Hanging chandeliers, &c.	809 1	. .	32 7 3
Gruel-Englemann, M.:			
Bookbinding	1,150 0	. .	46 0 0
Harrison, T.:			
Stationery	. .	. .	6 18 6
Henslow, H. S.:			
Packing cases and carriage	. .	. .	10 2 3
Holmes, Sir W. H.:			
Freight of British Guiana goods	. .	. .	10 19 5

III. Alphabetical List of Payments—*continued.*

	—		—		Total.		
	Fc.	*c.*	£	*s.* *d.*	£	*s.*	*d.*
Harvey, G. and A.:							
Freight of goods	.	.	.	.	50	15	1
Hubbard, Serjeant:							
Police at closing ceremony		.	.	.	12	8	0
Hardman, J. and Co.:							
For transport &c., of stained glass	.	.	.	.	60	0	0
Howitt, George, (Bradford Committee):							
Loan of damasks	.	.	.	.	6	14	0
Harrison and Sons:							
Copies of London Gazette	.	.	.	.	14	3	0
Haret, M.:							
Erection of naval trophy	4,850	0					
Loan of agricultural cases	2,245	0					
Exhibitor's case	125	0					
	7,220	0	.	.	288	16	0
Hancock, C. F.:							
Specimen of manufactures	207	50	.	.	8	6	0
Harding, S.:							
Hire of goods for decoration	625	0	.	.	25	0	0
Imperial Commission:							
Transport of goods from Dunkerque after the period appointed	5,385	47					
Covering tops of cases	1,643	30					
	7,028	77	.	.	281	3	0
Keilich, H.:							
Illustrations of Breeds of cattle	.	.	.	.	15	8	0
Krieger and Cie.:							
Hire of furniture	11,939	55					
Furniture purchased	365	0					
„ damaged	465	25					
	12,769	80	.	.	510	15	10
Lawson, Peter and Son:							
For specimens and arrangement of agricultural collection	.	.	.	.	618	8	0
Lightly and Simon, (Shipping Agents):							
Transport of goods to and from France	.	.	.	.	6,522	10	2
Logan, Sir W. (Commissioner for Canada):							
Fire-engine	.	.	.	.	142	0	0
Lapworth, Alfred:							
Damage to carpet	.	.	.	.	20	0	0
Lacasse, M.:							
Labour and materials	.	.	.	.	27	3	9
Lemaire, M.:							
Metre measures	150	50	.	.	6	0	5
Lamotte, M.:							
House repairs in Paris	493	65	.	.	19	14	11
Lesage, M.:							
House repairs in Paris	132	57	.	.	5	6	1
Leincroser, M.:							
Oil-cloth in Paris	151	0	.	.	6	0	10

III. Alphabetical List of Payments—*continued.*

	—		—			Total.		
	Fr.	*c.*	£	*s.*	*d.*	£	*s.*	*d.*
Lamy, M.:								
Loan of trucks, &c.	355	0	.		.	14	4	0
Lacasse, Petit, and Cie.:								
Carpenters' labour and materials	15,491	65	.		.	619	13	4
Leuchars, W.:								
Desks, portfolios, &c.	1,312	0	.		.	52	9	7
MacArthur, Sir William:								
Freight on Australian goods	.	.	71	10	7			
Six Australian cases	8,000	0	320	0	0			
						391	10	7
Mechi, J. J.:								
Cutlery	1,286	0	2	4	4			
			51	8	10			
						53	13	2
Miller, F. M.:								
Damage to work of art	.	.	.		.	50	0	0
Minton and Co.:								
Earthenware	.	.	.		.	5	0	0,
Manchester Committee:								
Freight on goods	.	.	148	10	0			
Loan of furniture hangings	.	.	9	1	9			
						157	11	9
McCracken, Messrs.:								
Freight and charges on return cases	.	.	.		.	143	8	10
McClure, J., and Son:								
Packing cases for pictures	.	.	.		.	5	19	0
Mint, (The Master of the),								
Fitting and transport of coin weighing machine	.	.	.		.	54	12	0
MacLeod, Norman:								
Office expenses paid by him in London	.	.	.		.	74	16	9
Marquet, M.:								
Firing for offices	232	0	.		.	9	5	7
Mesnard, M.:								
Baskets, brooms, &c.	142	25	.		.	5	13	10
Mellier, A.:								
Driving bands for machinery	604	35	.		.	24	3	6
Marx, M.:								
Painting, varnishing, &c.	155	0	.		.	6	4	0
Monbro, M.:								
Labour and materials	1,369	0	.		.	54	15	2
Mondin, M.:								
Loan of gear and labour	230	0	.		.	9	4	0
Mercier, M.:								
Printing	937	50	.		.	37	10	0
Moreno-Henriquès, M.:								
Removing and packing packing-cases	9,516	70						
Warehousing Canadian cases	279	35						
	9,796	5	.		.	391	16	10
Mitchell, J. B.:								
Damage	150	0	.		.	6	0	0
Masson, E.:								
Flowers for decoration	275	0	.		.	11	0	0

III. Alphabetical List of Payments—*continued.*

	—	—	Total.
	Fr. c.	£ *s. d.*	£ *s. d.*
Nepveu and Cie.:			
Labour, materials, carting, &c.	14,954 66		598 3 9
Osler, F. and Co.:			
Charges for glass candelabrum			20 0 0
Owen, P. C.:			
Disbursements in preparation of offices	1,321 10		52 16 11
Park, Patrick:			
Damage to work of art			150 0 0
Pim, Brothers, and Co.:			
Freight on goods			10 2 6
Perrier, M.:			
Firing for offices	348 0		13 18 5
Picard, M.:			
House repairs	412 40		16 9 11
Potier, M.:			
Painting, glazing, &c.	1,032 84		41 6 4
Platt, Brothers:			
Repairs of machinery	187 50		7 10 0
Paniss, E.:			
French Catalogues	450 0		18 0 0
Ralph, W. C.:			
Packing cases for coal collection			36 6 0
Reichmann, A.:			
Stationery in Paris	410 73		16 8 7
Riviere, R.:			
Bookbinding, &c.			29 2 0
Street, Brothers:			
Advertising in England			234 9 6
Saunders, W. Wilson:			
Insurance on works of art			2,715 12 6
Smyth, C. Piazzi:			
Philosophical apparatus		40 0 0	
Carriage of instruments		4 7 10	
			44 7 10
Stephenson, R. and Co.:			
Freight on machinery			128 9 3
Spence, B. E.:			
Freight on work of art			11 8 4
Seark, W.:			
Carriage of cases			6 17 8
Smith and Hawkes:			
Freight on goods			6 14 2
Stephens, E. B.:			
Damage to work of art			14 0 0
Smirke, Sydney:			
Damage to work of art			10 0 0
Seyffert, M.:			
House repairs	207 25		8 5 10
St. Jandeux:			
Labour and materials	131 0		5 4 10
Stocken, C.:			
Writing-cases	190 0		7 12 0
Trinity House, Corporation of the:			
Charges on models			52 8 0

III. Alphabetical List of Payments—*continued.*

	—	—	Total.
	Fr. *c.*	£ *s.* *d.*	£ *s.* *d.*
Thompson, C. Thurston:		125 2 0	
Photographs	575 0=	23 0 0	
Apparatus and chemicals	815 5=	32 12 0	
		39 16 0	
			220 10 0
Tolhausen, A.:			
Translations	635 0		25 8 0
Tessier, M.:			
Tools and other materials	293 30		11 14 8
Touzard, M:			
French journals	163 75		6 11 0
Tassot, M.:			
Papering, &c.	149 0		5 19 2
Vacher and Sons:			
Extra clerks, and copying, &c.			410 15 5
Vilmorin and Co.:			
Carriage	176 30		7 1 0
Varral, Middleton, and Co.:			
Works in machinery division	460 25		18 8 2
Waterlow and Sons:			
Stationery			15 6 0
Walker, James and Co.:			
Red cloth for decoration			590 3 10
Whitworth, Joseph and Co.:			
Freight on machinery			240 5 6
Weede, H.:			
Printing for coal collections			11 15 2
Westmacott, Sir R., R. A.:			
Cases, &c. for sculpture			14 5 0
Westmacott, R., R. A.:			
Charges for removing work of art		7 14 0	
Restoring group of sculpture		100 0 0	
			107 14 0
Westmacott, J. H.:			
Damage to work of art			25 0 0
Wood and Todhunter:		20 0 0	
Agency charges at Dunkerque	2,412 52	96 10 0	
Yardley, C.:			116 10 0
Police at Irongate Wharf, and 14, Charles St., Middlesex Hospital			71 8 0
Yarborough, Lord:			
Cases for models and carriage			14 12 2
Yapp, G. W.:			
Copies of translation of French tariff		30 0 0	
Charges for Gray's engine	250 0	10 0 0	
			40 0 0

Miscellaneous Accounts under £5.

Allsop, J.:—Baskets			2 2 0
Agnew, T. and Sons:—Packing-cases			3 8 0
Angot, V.:—Pullies	66 0		2 12 10
Bull, H. and Son:—Pasteboard boxes			4 1 3
Banwell, W.:—Packing-cases			4 11 0
Barry, Sir Charles:—Packing-cases			3 5 8

III. Miscellaneous Accounts—*continued.*

	—		—			Total.		
	Fr.	*c.*	£	*s.*	*d.*	£	*s.*	*d.*
Boyer, M. :—Chairs	48	0	.		.	1	18	5
Bentley, J. :—Repairing damage	.	.	.		.	3	0	0
Cartwright, S. :—Packing-cases	.	.	.		.	4	12	8
Campbell, Thomas :—Packing-cases	.	.	.		.	4	18	4
Cottingham, H. :—Packing-cases	.	.	.		.	2	2	0
Chaillot, M. :—House repairs	89	75	.		.	3	11	10
Cheron, M. :—Blowses for sweepers	84	0	.		.	3	7	2
Cail, J. F. and Cie. :—Work in machinery	62	96	.		.	2	10	5
Daudin, M. :—Stationery in Paris	69	70	.		.	2	15	9
Donat-Peauzzi, M. :—House repairs	39	60	.		.	1	11	8
Dufries, C. :—Ropes	74	40	.		.	2	19	6
Delarue and Hivert :—Labels	95	50	.		.	3	16	5
Edan, M. :—Boxes for photographs	57	0	.		.	2	5	7
Faulkner, F. M. :—Freight	.	.	.		.	2	13	4
Fisher, John ;—Packing-cases	.	.	.		.	1	11	6
General Steam Navigation Company :—Freight	.	.	.		.	4	15	7
Gaitz, M. :—House repairs	70	94	.		.	2	16	9
Gabereau, M. :—Lighting	83	90	.		.	3	7	2
Gervais M. :—Set of Medals	70	0	.		.	2	16	0
Houldsworth, and Co. :—Freight	.	.	.		.	4	1	0
Hardman, A. :—Cleaning machinery	115	0	.		.	4	12	0
Jordan, R. :—Parcels and sundries	.	.	.		.	3	17	0
Lens and Bass :—Packing-cases	.	.	.		.	3	6	6
Lourdee, M. :—Table cloths, dusters, &c.	116	0	.		.	4	12	10
Lacour, M. :—Earthenware for offices	87	65	.		.	3	10	1
Leroy, E. :—Cloth	96	0	.		.	3	16	10
Lesec, E. :—Tools	72	0	.		.	2	17	7
Maugham and Dixon :—Law charges	.	.	.		.	3	7	0
Morton, G. :—Cutlery	87	0	.		.	3	9	7
Newman, M. :—Damage	.	.	.		.	3	10	0
Noblet, H. and Co. :—Copies of system of classification	100	0	.		.	4	0	0
Roux, M. :—House repairs	85	20	.		.	3	8	2
Robert, Louis :—Photographs	91	50	.		.	3	13	2
Spicer and Clowes :—Catalogues	.	.	.		.	4	16	0
Sturbant and François :—Oil-cloth	78	40	.		.	3	2	9
Sergent, M. :—Mounting photographs	78	0	.		.	3	2	5
Troll·pe, J. and Sons :—Packing cases	.	.	.		.	2	9	0
Taplin, J. :—Cartage	.	.	.		.	4	15	6
Tapp, J. :—Glazed calico	112	45	.		.	4	10	0
Thompson, R. A. :—Season tickets for agents	100	0	.		.	4	0	0
Warrington and Co. :—Office Seal	.	.	.		.	1	15	0
Weld, C. B. :—Printing	.	.	.		.	2	15	0
Waite, Thomas :—Packing-cases	.	.	.		.	1	3	1
Incidental Payments :—Postage, parcels, messengers, cab-hire, catalogues, newspapers, &c.	.	.	.		.	602	8	8

IV.—Summary of Payments for Personal Services and Travelling Allowances from 10th June 1854 to 30th June 1856.

	—			Total.		
a. Executive Staff.—1854–5–6.	£	*s.*	*d.*	£	*s.*	*d.*
Henry Cole, C.B., General Commissioner, from June 1854 to December 1856:						
Salary	1,000	0	0			
Travelling expenses and personal allowance	827	11	3			
				1,827	11	3
Richard Redgrave, R.A., Commissioner for Fine Arts, from June 1854 to June 1856:						
Salary	1,000	0	0			
Fine Arts Report	100	0	0			
Travelling expenses and personal allowance	191	7	7			
				1,291	7	7
H.C. Owen, Capt. (now Lieut.-Col.), R.E., Secretary:						
Travelling expenses and allowance	.		.	81	3	1
Francis Fowke, Capt. R.E. (succeeded Lieut.-Col. Owen as Secretary), from August 1854 to March 1856:						
Salary and personal allowance	1,005	16	10			
Report on Military Art	64	0	0			
„ on Naval Art	50	0	0			
„ on Civil Engineering	100	0	0			
Travelling expenses	83	6	0			
				1,302	16	10
G. F. Duncombe, Assistant Secretary, from August 1854 to May 1856:						
Salary and personal allowance	453	8	4			
Translating Reports of MM. Arnoux and Bontemps	27	10	0			
				480	18	4
R. A. Thompson, Superintendent for Arrangement, from June 1854 to January 1856:						
Salary and personal allowance	763	15	5			
Report on Industrial Arrangements	50	0	0			
Travelling expenses	34	1	8			
				847	17	1
Philip C. Owen, Deputy Superintendent for arrangement, from June 1854 to 31st December 1855:						
Salary and personal allowance	371	5	3			
Travelling expenses	48	16	11			
				420	2	2
Falconer Atlee, Inspector for admission of Goods:						
One year's salary	.		.	250	0	0
C. S. Parker, assistant for fine arts:						
Salary and personal allowance	.		.	140	1	1
Henry Sandham, assistant for arrangement:						
Salary and personal allowance	.		.	295	0	6
William Matchwick, Registrar and financial clerk, from June 1854 to May 1856:						
Salary and personal allowance	.		.	448	2	10
b. Occasional Services						
Lyon Playfair, C.B., Secretary of Department of Science and Art:						
Travelling expenses and personal allowance	.		.	71	4	10
Norman Mac Leod, Registrar of Department of Science and Art:						
Travelling expenses and personal allowance	.		.	27	13	7

IV. Summary of Payments. &c.—*continued.*

	—			Total.		
	£	s.	d.	£	s.	d.
W. Fairbairn, arrangement of machinery :						
Travelling expenses and personal allowance .	.		.	61	0	0
T. Creswick, R. A., *John Bell*, *Henry Warren*, *F. Y. Hurlstone*, Committee for arranging the Pictures and Sculpture	.		.	100	0	0
	.		.	100	0	0
	.		.	100	0	0
	.		.	100	0	0
Hon. George Wrottesley, Capt., R.E. :						
Secretary to Committees of Science .	.		.	32	11	0
John Wilson, formation of agricultural collection :						
Payment for services . . .	157	10	0			
Travelling expenses and allowance, exclusive of Juror's allowance . . .	122	10	0			
				280	0	0
B. T. B. Gibbs, arrangement of agricultural implements :						
Payment for services . . .	100	0	0			
Travelling expenses . . .	24	2	6			
				124	2	6
C. Thurston Thompson, assistance in arrangement:						
Payment for services . . .	138	0	0			
Travelling expenses . . .	9	2	9			
				147	2	9
John Humphreys, Metropolitan committees and transport of goods :						
Salary and allowance . . .	345	7	4			
Travelling expenses . . .	48	14	7			
				393	1	11
George Wallis, assistance in arrangement :						
Payment for services . . .	100	0	0			
Travelling expenses . . .	25	2	0			
Report on Birmingham manufactures .	50	0	0			
				175	2	0
Gottfried Semper, superintendence of decoration :						
Payment for services and travelling expenses	.		.	105	9	10
Octavius Hudson :						
Travelling expenses . . .	.		.	16	2	1
R. G. Wylde, clerical assistance :						
Travelling expenses and personal allowance .	.		.	67	18	0
E. M. Conan, Fine arts and juries .						
Salary	.		.	61	5	0
H. T. Read, formation of coal collection :						
Salary and personal allowance . .	87	10	0			
Travelling expenses . . .	10	12	5			
Catalogue	20	0	0			
				118	2	5
J. J. Mayo, superintending accounts . .	100	0	0			
Travelling expenses and personal allowance .	27	4	0			
				127	4	0
H. W. Williams, preparing accounts for Audit Office	.		.	50	0	0
H. R. Lack, statistical information :						
Travelling expenses and personal allowance .	.		.	12	3	10
W. G. Groser, ticketing and numbering objects :						
Travelling expenses and personal allowance .	.		.	18	1	6
J. M. Langdale :						
Clerical services after close of Exhibition .	.		.	25	0	0
Sundry Persons paid weekly, according to the wages lists, from 10th June 1854 to 30th June 1856	.		.	3,294	13	6

V.—Services of Jurors.

Class.	—	— £	s.	d.	Total. £	s.	d.
3	*Amos, C. E.:*						
	Travelling expenses and allowance	.		.	24	5	4
9	*Arnott, Neil:*						
	Travelling expenses and allowance	79	0	0			
	Report	50	0	0			
					129	0	0
	Arnoux, M.:	.		.	50	0	0
	Report						
20	*Addington, S.:*						
	Travelling expenses and allowance	.		.	35	0	0
	Bontemps, M.:						
	Report	.		.	50	0	0
8	*Brewster, Sir David:*						
	Travelling expenses and allowance	46	5	2			
	Report	50	0	0			
					96	5	2
13	*Burgoyne, Sir John, Bart.:*						
	Travelling expenses and allowance	.		.	35	12	0
16	*Bird, W.:*						
	Travelling expenses and allowance	.		.	47	0	0
19	*Bazley, T.:*						
	Travelling expenses and allowance	.		.	37	6	0
20	*Butterfield, R. S.:*						
	Travelling expenses and allowance	.		.	73	4	0
22	*Beveridge, Erskine:*						
	Travelling expenses and allowance	.		.	75	16	0
30	*Barry, Sir Charles, R.A.:*						
	Travelling expenses and allowance	.		.	80	9	6
5	*Crampton, T. R.:*						
	Travelling expenses and allowance	.		.	65	0	0
8	*Carter, Alderman, J.:*						
	Travelling expenses and allowance	.		.	49	0	0
19	*Crum, Walter:*						
	Travelling expenses and allowance	.		.	57	8	6
27	*Clerk, Sir George, Bart:*						
	Travelling expenses and allowance	.		.	64	0	0
30	*Cockerell, C. R., R.A.:*						
	Travelling expenses and allowance	.		.	98	10	0
3	*Denison, J. Evelyn, M.P.:*						
	Report	.		.	52	0	0
10	*De la Rue, Warren:*						
	Travelling expenses and allowance	.		.	92	2	6
26	*De la Rue, Thomas:*						
	Travelling expenses and allowance	.		.	49	15	0
6	*Fairbairn, W.:*						
	Travelling expenses and allowance	59	0	0			
	Report	100	0	0			
					159	0	0
23	*Felkin, W.;*						
	Travelling expenses and allowance	.		.	59	0	0
10	*Graham, Thomas* (Master of the Mint):						
	Travelling expenses and allowance	.		.	27	0	0
21	*Gibson, T. F.:*						
	Travelling expenses and allowance	.		.	35	3	0
22	*Graham, Peter:*						
	Travelling expenses and allowance	.		.	47	0	0

V. Services of Jurors—*continued.*

Class.	—	—			Total.		
		£	*s.*	*d.*	£	*s.*	*d.*
1	*Hamilton, J. W.:*						
	Travelling expenses and allowance	.	.	.	55	11	10
2	*Hooker, Sir William:*						
	Travelling expenses and allowance	91	11	6			
	Report	100	0	0			
					191	11	6
18	*Hofmann, A. W.:*						
	Travelling expenses and allowance	.	.	.	57	0	0
18	*Hartley, J.:*						
	Travelling expenses and allowance	.	.	.	34	13	4
26	*Knight, Charles:*						
	Travelling expenses and allowance	39	0	0			
	Report	50	0	0			
					89	0	0
14	*Manby, Charles:*						
	Travelling expenses and allowance	.	.	.	80	2	6
15	*Moulson, T.:*						
	Travelling expenses and allowance	.	.	.	38	4	0
15	*Mechi, J. J.:*						
	Travelling expenses and allowance	.	.	.	36	1	0
22	*Mac Adam, J. Jun.:*						
	Travelling expenses and allowance	.	.	.	42	13	6
28	*Maclise, Daniel, R. A.:*						
	Travelling expenses and allowance	.	.	.	38	0	0
29	*Marshall, W. C., R. A.:*						
	Travelling expenses and allowance	.	.	.	42	10	0
11	*Owen, Richard:*						
	Travelling expenses and allowance	39	16	0			
	Report	50	0	0			
					89	16	0
4	*Rennie, George:*						
	Travelling expenses and allowance	.	.	.	77	13	6
28	*Robinson, J. H.:*						
	Travelling expenses and allowance	.	.	.	64	0	0
11	*Royle, J. Forbes, M.D.:*						
	Report	.	.	.	50	0	0
1	*Smyth, Warington:*						
	Travelling expenses and allowance	46	11	0			
	Report	50	0	0			
					96	11	0
5	*Shelburne, Lord:*						
	Travelling expenses and allowance	.	.	.	54	6	0
8	*Tyndall, J.:*						
	Travelling expenses and allowance	.	.	.	27	0	0
16	*Tylor, Alfred:*						
	Travelling expenses and allowance	18	10	0			
	Report	50	0	0			
					68	10	0
28	*Taylor, Frederick:*						
	Travelling expenses and allowance	.	.	.	69	0	0
3	*Wilson, John:*						
	Travelling expenses and allowance	.	.	.	75	1	2
7	*Willis, R.:*						
	Travelling expenses and allowance	108	16	6			
	Report	50	0	0			
					158	18	6

V. Services of Jurors—*continued.*

Class.	——	— £	s.	d.	Total. £	s.	d.
9	*Wheatstone, C.:*						
	Travelling expenses and allowance .	.		.	101	0	0
18	*Webb, John:*						
	Travelling expenses and allowance .	.		.	33	7	0
21	*Winkworth, T.:*						
	Travelling expenses and allowance .	63	13	0			
	Report	50	0	0			
					113	13	0
24	*Wyatt, M. Digby:*						
	Travelling expenses and allowance .	69	10	0			
	Report	91	0	0			
					160	10	0
29	*Westmacott, R., R. A.:*						
	Travelling expenses and allowance .	.		.	30	17	6

APPENDIX (B.)

FRANCE.

TABLE showing the RATES of IMPORT DUTIES levied in FRANCE on FOREIGN ARTICLES, previous to the 1st July 1853, as compared with those now (1st September 1856), in existence.

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Silk. Tow,—						
Refuse of cocoons, raw	100 kils.	free.	1 0	100 kils.	1 0	1 10
„ „ dyed	1 kil.	0 10	0 10	1 kil.	0 82	0 90
Carded, combed, and others	„	0 10	0 10	„	0 82	0 90
Spun (fleuret), raw	„	1 0	1 10	„	0 82	0 90
„ „ dyed	„	3 0	3 30	„	3 06	3 30
Grease, all kinds, —						
From India	100 kils.	2 0	8 0	100 kils.	6 0	13 0
„ Elsewhere	„	5 0		„	10 0	
Fish oil, blubber and grease from foreign fisheries,—						
From India	„	10 0	30 0	„	40 0	56 0
„ Countries out of Europe	„	15 0		„		
„ Entrepôts	„	20 0		„	48 0	
Spermaceti, raw, of foreign fisheries,—						
From India	„	5 0	15 0			
„ Countries out of Europe	„	7 50		„	20 0	22 0
„ Entrepôts	„	10 0				
Pressed	„	20 0	22 0	„	30 0	33 0
Refined	„	50 0	55 0	„	75 0	81 20
Bezoards	„	free.	free.	„	245 0	259 70
Crabs' eyes	„	„	„	„	17 0	18 70
Deers' marrow and bladders	„	„	„	„	13 0	14 30
Dried goats' blood	„	„	„	„	31 0	34 10
Antali	„	„	„	„	7 0	7 70
Bones,—						
Deers' heart	„	„	„	„	41 0	45 10
Cuttle fish	„	„	„	„	5 0	5 50
Horns of deer and snack	„	„	„	„	5 0	5 50
Scrapings or shavings,—						
Of deers' horns	„	„	„	„	9 0	9 90
Of ivory	„	„	„	„	21 0	23 10
Elks' feet	„	„	„	per 100	1 50	1 50
Tortoise-shells, backs and claws,—						
From countries out of Europe	„	„	60 0	100 kils.	30 0 to 70 0	150 0
Entrepôts	„	50 0		„	100 0	
Tortoise-shells, chippings or parings,—						
From countries out of Europe	„	free.	30 0	„	7 50 to 17 50	37 50
„ Entrepôts	„	25 0		„	25 0	
Horns of cattle, rough	„	0 10	1 0	„	0 10	0 10
Wolf's teeth	„	0 10	1 0	„	5 0	5 50
Chestnuts and meal	„	1 0	3 0	„	8 0	8 80
Feculæ, exotic,—						
From India	„	5 0	20 0			
„ Other countries out of Europe	„	10 0		„	7 0	7 70
„ Entrepôts	„	15 0				
Fresh fruits,—						
Carobs	„	0 25	1 0	„	5 0	5 50
Others, exotic	„	free.	4 0	„	8 0	8 80
„ indigenous	„	free.	2 0	„	4 0	4 40
Raisins, dried	„	0 25	2 0	„	16 0	17 60
Sesamum seed, by Sea,—						
From India, French establishments	„	0 40	—	„	1 0	—
„ Elsewhere	„	2 0	7 0	„	4 50	14 0
„ America, French colonies	„	0 80	—	„	2 0	—
„ West Coast of Africa	„	3 0		„	7 0	
„ White, Baltic, Black, and Mediterranean Seas, and from beyond Capes Razat and Matapan	„	4 0	7 0	„	10 0	14 0
„ Elsewhere	„	5 0		„	12 50	

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Rape and colza seeds, by Sea,—						
From India, French establishments	100 kils.	0 20	—	100 kils.	0 50	—
„ Elsewhere	„	1 0	5 0	„	2 50	9 0
„ America, French colonies	„	0 40	—	„	1 0	—
„ West Coast of Africa	„	1 50	5 0	„	3 50	9 0
„ White, Baltic, Black, and Mediterranean Seas, and Capes Matapan and Razat	„	2 0		„	5 0	
„ Elsewhere	„	3 0		„	7 50	
Flax and other oil seeds, by Sea,—						
From India, French establishments	„	0 10	—	„	0 25	—
„ Elsewhere	„	0 75	4 50	„	1 50	8 0
„ America, French colonies	„	0 20	—	„	0 50	—
„ West Coast of Africa	„	1 0	4 50	„	3 0	8 0
„ White, Baltic, Black, and Mediterranean Seas, and beyond Capes Razat and Matapan	„	1 50		„	4 0	
„ Elsewhere	„	2 50		„	6 50	
Fruits for distilling,—						
Cactus figs and juniper and myrtle berries	„	free.	1 10	„	1 0	1 10
Sowing seeds,—						
Garden and flower	„	0 10	1 0	„	1 0	1 10
Madder and carding thistle						
Forest trees						
Cotton						
Meadow						
Amomums and Cardamums,—						
From Countries out of Europe	„	free.	20 0	„	123 0	131 60
„ Entrepôts	„	10 0				
Lac natural or resin,—						
From Countries out of Europe	„	free.	15 0	„	0 50	15 0
„ Entrepôts	„	10 0		„	10 0	
Other sorts,—						
From Countries out of Europe	„	free.	30 0	„	8 0	30 0
„ Entrepôts	„	20 0		„	20 0	
Olive oil of country of production (except Algiers and Sardinia).	„	10 0	15 0	„	25 0	30 0
„ „ Elsewhere	„	13 0		„	28 0	
Palm and Cocoa Oil,—						
From French colonies and Indian settlements.	„	1 50	—	„	4 0	—
„ West Coast of Africa	„	1 50	10 0	„	4 0	15 0
„ Countries out of Europe	„	5 0		„	12 50	
„ Entrepôts	„	8 0				
Oily seeds (except from Algiers)	„	10 0	15 0	„	25 0	30 0
Caoutchouc or gutta percha,—						
From Countries out of Europe	„	free.	10 0	„	7 50	25 0
„ Entrepôts	„	5 0		„	15 0	
Bird lime	„	free.	free.	„	15 0	16 50
Roots, not otherwise denominated,—						
From Out of Europe	„	10 0	20 0	„	15 0	25 0
„ Elsewhere	„				20 0	
Citron and orange peel	„	free.	free.	„	17 0	18 70
Fire-wood	per stère.	„	„	per stère.	0 5	0 5
Charcoal	per cubic mètre.	„	0 5	per cubic mètre.	0 1 to 0 5	0 1 to 0 5
Scented woods (Sassafras and others),—						
From Countries out of Europe	100 kils.	„	15 0		5 0	15 0
„ Entrepôts	„	10 0			15 0	35 0
					10 0	
					30 0	
Dyewoods, in logs, Barberry and Fustic	„	free.	free.	„	0 10	2 0
„ Pernambuco,—					1 50	
From Countries out of Europe	„	„	6 0	„	5 0	12 0
„ Entrepôts	„	5 0			9 0	
Gourds, empty	„	free.	free.	„	13 0	14 80

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Canes and reeds, bamboos,—						
From Countries out of Europe	100 kils.	free.	20 0	100 kils.	60 0 / 80 0	120 0
„ Entrepôts	„	10 0		„	100 0	
Canes and reeds, garden	„	free.	free.	„	8 0 / 18 0	8 80 / 19 80
Filaments of cotton,—						
From French colonies	„	„	—	„	5 0	—
Lime-tree bark for rope making	„	„	free.	„	0 10	0 10
Curcuma roots,—						
From India	„	„				
„ Countries out of Europe	„	8 0	20 0	„	10 0 / 22 0	50 0
„ Entrepôts	„	15 0			36 0	
Quercitron,—						
From Countries out of Europe	„	2 0	6 0	„	4 0 / 7 0	9 0
„ Entrepôts	„	4 0				
Bark, Pine, not ground	„	free.	free.	„	0 10	0 10
„ Fir, for tanning, not ground	„	„	„	„	0 10	0 10
„ Others, not ground	„	„	„	„	0 10	0 10
Wold	„	„	„	„	1 0	1 10
Carthamus, flowers of,—						
From Countries out of Europe	„	1 0	10 0	„	12 0 / 15 0	18 0
„ Entrepôts	„	6 0				
Gall nuts,—						
From Countries out of Europe	„	free.	4 0	„	5 0 / 7 0	12 0
„ Entrepôts	„	3 0				
Beet root	„	0 30	0 30	„	0 50	0 50
Tree plants	„	free.	free.	„	0 50	0 50
Bulbs and bulbous roots	„	„	1 10	„	5 0	5 50
Peat and Turf	„	„	free.	per cubic mètre.	raw 10 / carb. 5	0 10 / 0 5
Millstones, from less than 1299 to more than 1949 millimètres in diameter	each.	„	„	each.	2 50 to 7 50	2 50 to 7 50
Grindstones, from less than 406 to above 1218 millimètres in diameter	„	0 10	0 30	„	0 10 / 5 0	0 10 / 5 0
Sharpening stone, rough	100 kils.	free.	1 0	100 kils.	2 0	2 20
Marl	„	„	1 0	„	0 10	0 10
Pipeclay	„	„	1 0	„	0 10	0 10
Chalk	„	„	1 0	„	5 0	5 50
Lime	„	0 1	1 0	„	0 1 / 0 20	0 1 / 0 20
Jet	„	free.	free.	„	1 0	1 10
Iron ore,—	„	„	0 25	„	free.	1 0
Cast, (refined,) weighing 15 kils. or more,—						
Pig	„	7 0	7 70	„	12 0	13 20
Plated	„	40 0	44 0	„	70 0	76 0
Wire	„	30 0	33 0	„	60 0	65 50
Old, broken	„	4 0	4 40	„	12 0	13 0
„ „ by land	„	—	4 0	„	—	13 0
Cast, (raw,) in pigs of more than 15 kilogrammes,—						
By Sea	„	4 0	4 40	„	7 0	7 70
„ land	„	—	4 0	„	—	4 0 / 7 0
Iron ore, drawn,—						
In flat and square bars according to dimensions — From	„	10 0	11 0	From	15 0	16 50
In flat and square bars according to dimensions — To	„	14 0	15 40	To	37 50	41 20
In round bars, according to dimensions — From	„	12 0	13 20	From	25 0	27 50
In round bars, according to dimensions — To	„	14 0	15 40	To	37 50	41 20
Iron, sheet	„	20 0	22 0	„	40 0	44 0
Steel, in bars, natural or cast	„	30 0	33 0	„	60 0 / 120 0	65 50 / 128 50
„ in sheets	„	50 0	55 8	„	80 0	86 50
Tin, raw, from India	„	free.	5 0	„	0 10	5 0
Stearic acid	„	25 0	27 50	„	60 0	65 50
Alkali, potash,—						
From French colonies	„	3 0	—	„	10 0	—
„ Countries out of Europe	„	6 0	12 0	„	15 0 / 18 0	21 0
„ Entrepôts	„	10 0				

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Nitrate of potash and soda,—						
From beyond Capes Horn and Good Hope	100 kils.	1 0	11 0			
„ Countries out of Europe	„	6 0		100 kils.	7 50	25 0
„ Entrepôts	„	8 0			20 0	
Wine lees	„	free.	free.	„	1 0	1 10
Cochineal, in grains	„	„	„	„	1 0	1 10
Stearic acid, wrought	„	35 0	38 50	„	85 0	91 70
Candles, common	„	10 0	11 0	„	25 0	27 50
Wines, common	per hect.	0 25	0 25	per hect.	15 0	15 0
					35 0	35 0
Kirschwasser (cherry brandy)	„	15 0	15 0	„	200 0	200 0
Old printing types	100 kils.	5 0	5 50	100 kils.	10 0	11 0
Coal, by sea, from Sables d'Olonne exclusively, to Dunkirk inclusively.	„	0 30	0 80	„	0 50	1 0
„ at all other places	„	0 15	0 65	„	0 30	0 80
Coke	„	half above coals.		„	double of coals.	
Asses	each.	free.	free.	each.	0 25	0 25
Kids	„	„	„	„	0 25	0 25
Dogs	„	„	„	„	0 50	0 50
Game	—	„	„	—	2 %	ad val.
Bee-hives	each.	„	„	each.	1 0	1 0
Skins, dressed Lamb	100 kils.	0 10	1 0	100 kils.	1 0	1 10
„ Rabbit, undressed	„	free.	free.	„	1 0	1 0
„ Seal, dry	„	0 10	5 0	„	17 0	18 70
„ „ fresh	„				1 0	1 10
Silk, in cocoons	„	free.	free.	„	1 0	1 10
Wax, refuse of	„	„	„	„	5 0	5 50
Eggs	„	„	„	„	0 50	0 50
Honey	„	1 0	6 0	„	17 50	36 0
					33 50	
Rennet	„	free.	free.	„	0 50	0 50
Fresh water fish, Fresh	„	„	„	„	0 50	0 50
Pearls	1 hectog.	„	„	1 hectog.	0 50	0 50
Elephants' teeth, less than 1 kil.,—						
From beyond Europe	100 kils.					
„ Entrepôts	„	50 0	60 0	100 kils.	50 0 to 110 0	140 0
Elephants' grinders,—						
From beyond Europe	„	free.				
„ Entrepôts	„	5 0	10 0	„	25 0 to 55 0	70 0
Mother of pearl, Raw,—						
From India	„	free.	free.	„	10 0	35 0
„ Elsewhere	„	15 0	25 0	„	25 0	35 0
Potatoes	„	free.	free.	„	0 50	0 50
Sago,—						
From India	„	5 0				
„ beyond Europe	„	10 0	20 0	„	10 0 20 0 30 0	40 0
„ Entrepôts	„	15 0				
Salep	„	(same as Sago.)		„	86 0	86 50
Sugar, 1st type and inferior shade,—						
From China, Cochin China, Philippines, and Siam.	„	45 0			52 0	
From Other countries of India	„	47 0	65 0	„	54 0	72 0
„ beyond Europe	„	50 0			57 0	
„ Entrepôts	„	60 0			67 0	
„ Above the 1st type, also syrups,—						
From China, Cochin China, &c.	„	48 0			55 0	
„ Other countries of India	„	50 0			57 0	
„ beyond Europe	„	53 0	68 0	„	60 0	75 0
„ Entrepôts	„	63 0			70 0	
Molasses, foreign, for transformation to alcohol,—						
From India, South America, and the Antilles.	„	free.				
From Elsewhere	„	2 0	3 0	„	Prohibited.	
Gums, from Europe	„	free.	1 10	„	1 0	1 10
Camphor, raw,—						
From India	„	20 0				
„ beyond Europe	„	30 0	50 0	„	50 0 50 0 60 0	75 0
„ Entrepôts	„	40 0				

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Rhubarb, Root,—						
From India	100 kils.	35 0	65 0	100 kils.	75 0 100 0 150 0	175 0
„ beyond Europe	„	45 0				
„ Entrepôts	„	55 0				
Tow, of hemp or flax, for Sails	„	free.	free.	„	8 0	8 80
Tamarinds,—						
From beyond Europe	„		20 0	„	40 0	44 0
„ Entrepôts	„	10 0				
Fruit, not otherwise described,—						
From beyond Europe	„	free.	20 0	„	25 0 35 0	40 0
„ Elsewhere	„	10 0				
Timber,—						
Elm, Pine, Fir, and other common wood, not sawn.	stère.	0 5	0 10	stère.	0 10	0 10
Sawn and above 80 millimètres thick	„	0 5	0 10	„	0 15	0 15
„ less than „ „ „	per 100 mètres long.	0 5	1 0	100 mètres long.	1 0	1 0
Walnut,—						
Sawn into boards of and above 1 mètre and 46 centimètres in length, and more than 80 millimètres thick.	stère.	free.	0 15	stère.	0 15	0 15
From 27 to 80 millimètres thick	per 100 mètres long.	„	1 0	100 mètres long.	1 0	1 0
Other sorts by land, Unsawn	stère.	„	0 10	stère.	0 10	0 10
Sawn, of and above 80 millimètres thick	„	„	0 10	„	0 15	0 15
„ „ less than 80 „ „	per 100 mètres long.	„	1 0	100 mètres long.	1 0	1 0
By Sea, unsawn	stère.	0 5	0 10	stère.	0 10	0 10
Sawn, of more than 80 millimètres thick	„	0 5	0 10	„	0 15	0 15
„ less than 80 „ „	per 100 mètres long.	0 5	1 0	100 mètres long.	1 0	1 0
Cork wood, except from Algiers	100 kils.	0 50	5 0	100 kils.	6 0	1 10
Wood for cabinet-making,—						
From French colonies and Senegal	„	free.	free.	„	0 50	0 50
Vegetables, green	„	„	„	„	0 50	0 50
Forage, hay and straw	„	„	0 50	„	0 10	0 10
Hops	„	45 0	49 50	„	60 0	65 50
Carding thistles	„	free.	free.	„	1 0	1 10
Rags	„	„	1 0	„	0 10	0 10
Oilcakes	„	„	free.	„	0 50	0 50
Gems, rough	„	„	„	„	0 25 0 50	0 25 0 50
Agates	„	„	„	„	15 0	16 50
Rock crystal	„	„	„	„	62 0	67 60
Nickel, 1st fusion	„	„	„	„	5 0	5 50
Arsenic, metal	„	„	„	„	17 0	18 70
Manganese	„	„	1 0	„	1 0	1 10
Basket work,—						
Rough	„	6 0	7 0	„	15 0	16 50
Peeled	„	12 0	14 0	„	25 0	27 50
Split or cut	„	20 0	24 0	„	35 0	38 50
Alkalies,—						
Vegetable Ashes, live, washed or charred	„	free.	free.	„	0 10 1 0	0 10 1 10
Oxydes,—						
Cobalt pure or siliceous	„	„	„	„	0 50	0 50
Copper	„	„	„	„	7 0	7 70
Iron	„	„	1 0	„	2 0	2 20
Tin	„	„	free.	„	2 0	2 20
Salts,—						
Sulphate of spath	„	„	1 0	„	1 0	1 10
Acetate of iron, liquid	„	„	free.	„	5 0	5 50
Kermes, in grains	„	„	„	„	1 0	1 10
Black, natural (mineral)	„	„	1 0	„	10 0	11 0
Bleak scales	„	„	free.	„	5 0	5 50
Crushed apples and pears	„	„	„	„	1 0	1 0
Broken Glass	„	„	1 0	„	0 10	0 10

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Machinery, complete—						
Steam Engines and Machines,—						
Stationary	100 kils.	25 0	27 50	100 kils.	30 0	33 0
For navigation	„	35 0	38 50	„	45 0	49 50
Locomotive, without tenders	„	40 0	44 0	„	65 0	70 70
Other than steam,—						
For Spinning	„	40 0	44 0	„	45 0	49 50
„ Weaving	„	15 0	16 50	„	20 0	22 0
„ Carding flax and hemp	„	30 0	33 0	„	40 0	44 0
„ making Tulle	„	60 0	65 50	„	80 0	86 50
„ „ endless Paper and Printing	„	30 0	33 0	„	40 0	44 0
„ Agriculture	„	15 0	16 50	„	25 0	27 50
„ Embanking with wooden bodies and cast iron wheels.	„	20 0	22 0	„	25 0	27 50
„ River Boats, tenders, boilers, gasometers, &c. of iron.	„	30 0	33 0	„	45 0	49 50
Not otherwise described, weighing 100 kils. or less.	„	65 0	70 70	„	80 0	86 50
100 „ to 200	„	45 0	49 50	„	60 0	65 50
200 „ „ 1.000	„	35 0	38 50	„	50 0	55 0
1,000 „ „ 2,500	„	30 0	33 0	„	40 0	44 0
2,500 „ „ 5,000	„	25 0	27 50	„	30 0	33 0
above 5,000	„	20 0	22 0	„	20 0	22 0
Of cast iron, weighing 25 kils or less	„	80 0	86 50	„	100 0	107 50
25 kils. to 50	„	65 0	70 70	„	80 0	86 50
50 „ „ 100	„	55 0	60 20	„	70 0	76 0
100 „ „ 200	„	45 0	49 50	„	60 0	65 50
200 „ „ 1,000	„	35 0	38 50	„	50 0	55 0
1,000 „ „ 2,500	„	25 0	27 50	„	40 0	44 0
2,500 „ „ 5,000	„	20 0	22 0	„	30 0	33 0
above 5,000	„	15 0	86 50	„	20 0	22 0
Of wrought iron, 5 kils. or less	„	100 0	107 50	„	120 0	128 50
5 kils. to 25	„	80 0	86 50	„	110 0	118 0
25 „ „ 50	„	70 0	76 0	„	100 0	107 50
above 50	„	60 0	65 50	„	80 0	86 50
Drainage Pipes	„	15 0	—	„	20 0 65 0	—
Scythes	„	120 0	128 50	„	150 0	160 0
Tools, files, and rasps,—						
Coarse, common	„	75 0	81 20	„	80 0	86 50
Fine, for polishing, 6½ inches and more in length.	„	180 0	191 50	„	200 0	212 50
Less than 6½ inches	„	225 0	238 70	„	250 0	265 0
Other instruments of iron,—						
Edged with steel	„	125 0	133 70	„	140 0	149 50
Of pure steel	„	175 0	186 20	„	200 0	212 50
Metallic web,—						
Iron	„	75 0	81 20	„	100 0	107 50
Pure steel	„	150 0	160 0	„	200 0	212 50
Skins,—						
Dressed and tanned Hog	„	200 0	200 0	—	Prohibited.	
„ „ large	„	45 0	45 0			
„ „ small	„	120 0	120 0			
Curried, for boots	„	200 0	200 0			
„ Other purposes	„	100 0	100 0			
Dressed in alum, Hungarian tan	„	40 0	40 0			
„ „ tawed	„	50 0	50 0			
Wool,—						
Common, from beyond Europe	„	5 0	15 0	ad val.	15 % 20 %	20 % plus 3 fcs. per 100 kils.
„ „ Elsewhere	„	10 0				
Fine, from beyond Europe	„	10 0	20 0	„	15 % 20 %	
„ „ Elsewhere	„	15 0				
Washed, Common, from beyond Europe	„	10 0	25 0	„	30 %	30 %
„ „ „ Elsewhere	„	20 0				
„ Fine, from beyond Europe	„	22 50	37 50	„	30 %	30 %
„ „ „ Elsewhere	„	32 50				
Cotton, Raw, for Cordage	„	free.	free.	100 kils.	0 10	0 10

FRENCH TARIFF—*continued.*

ARTICLES.	Existing Duties, 1856.			Duties previous to 1st July 1853.		
	—	French Vessels.	Foreign Vessels.	—	French Vessels.	Foreign Vessels.
		Frs. c.	Frs. c.		Frs. c.	Frs. c.
Iron Rails for railroads	100 kils.	6 0	6 0	100 kils.	10 0 to 14 0	11 0 to 15 40
„ Ribs for vessels	„	free.	free.	„		
„ Knees	„	„	„	„		
Cordage of Cocoa fibres (bastings)	„	5	5 50	„	25 0	27 50
Millet	„	0 25	0 25	„	2 50 to 10 0	11 0
Resin, all sorts,—						
From beyond Europe	„	free.	free.	„	free.	15 0
„ Entrepôts	„	8 0	13 0	„	10 0	15 0
Masts of 40 centim. and above in diameter	each.	free.	free.	each.	7 50	7 50
„ 25 to 40	„	„	„	„	3 0	3 0
Spars, 15 centim. to 25	„	„	„	„	0 75	0 75
„ 11 „ 15	„	„	„	„	0 20	0 20
„ 6 „ 11	„	„	„	„	0 10	0 10
Lathwood of and under 2 mètres long	per 1,000	0 10	1 50	per 1000.	0 50	0 50
2 to 4					2 0	2 0
4 and above					10 0	10 0
Tobacco (imported into Algeria from French Entrepôts),—						
In leaf and stalks	100 kils.	20 0	20 0	100 kils.	ad valorem.	
Elsewhere	„	25 0	25 0	„		
Manufactured	„	40 0	40 0	„		
Fish, salt and pickled,—						
From French Colonies	„	25 0	—	„	10 0	10 0
Elsewhere					100 0	107 50

Statistical Department, Board of Trade,
1st October 1856.

(Signed) A. W. FONBLANQUE.

APPENDIX (C.)

CORPS LEGISLATIF.

Annexe au procès-verbal de la séance du 9 Juin.

Projet de loi portant retrait des prohibitions inscrites dans le tarif des douanes de France.

(Adopté par le conseil d'Etat.)

ART. 1er. A partir du 1er Janvier 1857, seront levées et remplacées par les droits ci-après les prohibitions existantes à l'importation des marchandises dont la désignation suit :

Sucre raffiné, d'ailleurs que des colonies Françaises: par navires Français, 80 fr. les 100 kil. ; par navires étrangers, 85 fr. les 100 kil.

Cristal de roche ouvré, 2 fr. le kil.

Curcuma en poudre, 40 fr. les 100 kil.

Fonte en morceaux pesant moins de 15 kil.: brute, autre que la fonte aciéreuse de Styrie et de Carinthie ; épurée dite mazée; de toute autre espèce, mêmes droits que les ouvrages en fonte selon l'espèce.

Fer forgé en massiaux ou prismes, 10 fr. les 100 kil.

Fils de laiton (cuivre allié de zinc) polis ou non polis, de toute sorte, 100 fr. les 100 kil.

Produits chimiques: chlorure de mercure, 3 fr. le kil.; extraits de quinquina non spécialement tarifés, alcalis végétaux et leurs sels, 90 fr. le kil.; phosphore, 2 fr. le kil. ; non dénommés, 20 0/0 de la valeur à convertir en droits spécifiques par le comité consultatif des arts et manufactures.

Extraits de bois de teinture, 30 fr. les 100 kil.

Garancine, 80 fr. les 100 kil.

Savons, autres que de parfumerie; blancs ou marbrés, composés d'alcalis et d'huile d'olive ou de graines grasses, purs ou mélangées de graisses animales, 20 fr. les 100 kil. ; de graisses animales, purs ou mélangées de résine, 18 fr. les 100 kil. ; d'huiles de palme ou de coco, purs ou mélangées de résine, 15 fr. les 100 kil.

Chicorée moulue, mêmes droits que les cafés importés des entrepôts d'Europe.

Poterie de terre de pipe (faïence fine) et de grès fin, ayant la couleur naturelle de la pâte: assiettes et plats, 33 fr. les 100 kil. ; autre, 66 fr. les 100 kil.

Dº imprimés: assiettes et plats, 60 fr. les 100 kil.; autre, 90 fr. les 100 kil.

Dº peinte, dorée, ou autrement ornée, 165 fr. les 100 kil.

Verres et cristaux: bombonnes, dames-jeannes, et grandes bouteilles de toute sorte, en verre de couleur claire ou foncée, 7 fr. les 100 kil. ; bouteilles de demi-litre et au-dessous, 9 fr. les 100 kil. ; tuiles et pannes en verre, 10 fr. les 100 kil.

Verres à vitres: blancs, de toute épaisseur et dimension, unis ou gondolés, 25 fr. les 100 kil. ; colorés ou à dessins vitrifiés, 50 fr. les 100 kil. ; petits miroirs, ayant au plus 40 cent. de côté, soit 16 décimètres de surface, non étamés, 60 fr., étamés, 75 fr. les 100 kil. ; ustensiles de laboratoire, 10 fr. les 100 kil.; objets de toute sorte, blancs, unis, ou moulés, sans autre taille que le *ponti*, ceux dits *en mousseline* exceptés, 65 fr. les 100 kil. ; blancs taillés, 140 fr. les 100 kil. ; objets de lustrerie, blancs ou colorés, unis ou taillés, 2 fr. 50 le kil. ; objets en verre ou cristaux colorés, unis, 2 fr. 50 le kil. ; verrerie *mince*, dite *mousseline*, unie ou taillée, 6 fr. 50 le kil. ; objets de tout genre, en verre coloré taillé, 6 fr. 50 le kil.; objets blancs ou colorés, unis ou taillés, ornés de gravures, dorures, peintures, et bronze, 6 fr. 50 le kil.

Fils de coton, simples écrus, de N° 1 au N° 30 métrique inclusivement, 1 fr. 20 le kil.

Du N° 31 au N° 45 métrique inclusivement, le kil., 0,04 c., multipliés par le N° de fil.

Du N° 46 au N° 140 métrique inclusivement, le kil., 0,05 c., multipliés par le N° du fil.

Au-dessus du N° 140, le kil., 7 fr.

Fils simples blanchis, les droits ci-dessus augmentés de 10 0/0.

Retors écrus, les droits des fils simples écrus augmentés de 15 0/0.

Retors blanchis, mêmes droits que les fils retors écrus, augmentés de 10 0/0.

Les fils de coton importés en paquet devront être dévidés d'après le système métrique. Les fils importés en bobines ou en canettes devront être accompagnés d'une échevette dévidée d'après le système métrique, avec indication du numéro du fil.

Le même colis ne pourra contenir que du fil du même numéro et de même espèce.

Les dispositions de la loi du 2 Juillet 1836, relatives à la restriction de poids, à la marque et à la saisie dans l'intérieur des cotons filés, sont abrogées.

Fils de laine non dénommés, valant au kil. 4 fr. ou moins, 1 fr. 20 le kil.; plus de 4 fr. et pas plus de 6 fr., 1 fr. 80 le kil.; plus de 6 fr., 3 fr. 50 le kil.

L'importation des fils de laine sera soumise aux mêmes conditions et restrictions que celle des fils de coton.

Les dispositions de la loi du 6 Mai 1841, relatives à la marque et à la saisie, dans l'intérieur, des fils de laine, sont abrogées.

Fils de poil non spécialement tarifés, mêmes droits que les fils de poils de chèvre.

Tissus de coton, nankin, par navires Français: de l'Inde, 1 fr. le kil.; d'ailleurs, 4 fr.; par navires étrangers, 5 fr. le kil.

La formalité de l'estampillage, prescrite à l'égard du nankin par la loi du 16 Décembre 1848, est supprimée.

Tissus de coton purs, unis ou croisés, dits calicots, percales, jaconas, coutils, printanière, etc., présentant, en chaine, plus ou moins découverts, dans l'espace de 5 millimètres.

Moins de 15 fils, écrus, 1 fr. 10; blancs, 1 fr. 20 c.; teints ou imprimés, 1 fr. 95 le kil.;

15 fils et moins de 20 fils, écrus, 1 fr. 55; blancs, 1 fr. 65; teints ou imprimés, 2 fr. 75 c. le kil.

20 fils et moins de 25 fils, écrus, 3 fr. 15; blancs, 3 fr. 25; teints ou imprimés, 5 fr. 25 le kil.

25 fils et au-dessus, écrus, 8 fr. 25; blancs, 8 fr. 60; teints ou imprimés, 12 fr. 35 le kil.

Linge de table ouvragé et damassé, mêmes droits que les tissus unis selon l'espèce, augmentés de 10 0/0.

Mouchoirs écrus, 3 fr. 40; blancs, 3 fr. 60; teints ou imprimés, 4 fr. 25 le kil.

Mousseline, gaze, organdi, tarlatane, etc., unis ou brochés, présentant, en chaîne, plus ou moins découverts, dans l'espace de 5 millimètres;

Moins de 12 fils, écrus, 2 fr. 25; blancs, 2 fr. 40; teints ou imprimés, 3 fr. 80 le kil.;

12 fils et pas plus de 15 fils, écrus, 11 fr. 90; blancs, 12 fr. 50; teints ou imprimés, 17 fr. 25 le kil.

16 fils et au-dessus, écrus, 33 fr. 20; blancs, 34 fr.; teints ou imprimés, 45 fr. 65.

Mêmes étoffes brodées: pour meubles, le double des droits ci-dessus suivant l'espèce; autres, mêmes droits que les tissus suivant l'espèce, plus 20 pour cent de la valeur.

Tulles et dentelles fabriqués au métier, mêmes droits que les tissus brodés pour meubles, de 1 fil et au-dessus.

Couvertures, mêmes droits que les tissus unis ou croisés, de 15 fils et de moins de 20 fils, selon l'espèce.

Bonneterie, rubanerie, et passementerie, mêmes droits que les tissus unis ou croisés de 20 fils et de moins de 25 fils, selon l'espèce.

Tissus de lin ou de chanvre: mouchoirs et autres objets en batiste, tels que devants de chemises, cols, manchettes, fichus, etc., brodés en fil de coton ou de lin, mêmes droits que le tissu dont ils sont formés, plus 20 0/0 de la valeur.

Tulle, mêmes droits que les dentelles de fil.

Tissus de crin non spécialement tarifés, 150 fr. les 100 kil.

Tissus le laine pure non dénommés, valant au kil. : draps et casimirs, tissus similaires et feutrés, de 4 à 9 fr. inclusivement, 2 fr. 85 ; de 9 à 18 fr. inclusivement, 5 fr. 05 ; plus de 18 fr., 8 fr. 75.

Tissus légers, mérinos, mousseline de laine, toile à blutoir, burail ou crépons de Zurich, etc., valant au kil. de 3 à 8 fr. inclusivement, 2 fr. 60 ; de 8 à 15 fr. inclusivement, 4 fr. 45 ; plus de 15 fr., 7 fr. 10.

Couvertures et molletons, valant au kil. de 2 à 6 fr. inclusivement, 1 fr. 65 ; de 6 à 10 fr. inclusivement, 2 fr. 95 ; plus de 10 fr., 4 fr. 65.

Bonneterie orientale, valant au kil. de 10 à 15 fr. inclusivement, 4 fr. 80 ; de 15 à 25 fr. inclusivement, 5 fr. 60 ; plus de 25 fr., 6 fr. 50 le kil. ; ordinaire et ouvrages en tapisserie faits à la main et à l'aiguille sur canevas, valant au kil. de 3 à 8 fr. inclusivement, 2 fr. 10 ; plus de 8 fr., 4 fr. 10.

Châles : comme les tissus dont ils sont formés, avec addition, pour les châles brochés, de 30 0/0, si le brochage couvre au moins un quart de la surface du tissu, et de 60 0/0, s'il s'étend sur les trois quarts au moins de cette surface.

Lisières de draps, mêmes droits que la laine en suint, selon la qualité.

Tissus de poils de cachemire fabriqués aux fuseaux dans les pays hors d'Europe, autres que les châles et écharpes, 6 fr. le kil ; autres que ceux dénommés au tarif, mêmes droits que les tissus de crin.

Tissus de soie, autres que les foulards et les crêpes : de l'Inde et de tous autres pays hors d'Europe : droits actuels des pays d'origine en droiture ; d'ailleurs, mêmes droits que les tissus similaires d'origine Européenne, augmentés d'un quart.

Etoffes pures, brochées d'or ou d'argent faux, mêmes droits, selon l'espèce, que les étoffes mélangées de fil ; mêlées de fil et d'or ou d'argent faux, *idem.*

Gaze mêlée d'or ou d'argent faux, mêmes droits que la gaze mêlée de fil.

Tulle de soie uni, 15 0/0 de la valeur ; broché ou brodé, en pièces ou en bandes, 30 0/0 de la valeur.

Tissus de bourre de soie (fleuret) : tissus façon cachemire, mêmes droits que les autres tissus en bourre de soie, selon l'espèce.

Etoffes mélangées d'or ou d'argent faux, mêmes droits que les étoffes en bourre de soie pure.

Tissus d'écorces d'arbre, d'ortie, et de tous autres végétaux filamenteux non dénommés, y compris les pagnes et rabanes, mêmes droits que les tissus de phormium tenax, d'abaca, et de jute.

Habillements ou vêtements confectionnés, 30 0/0 de la valeur.

Peaux préparées au tan, simplement tannées et pour toute destination : de porc, 200 fr. les 100 kil. ; autres, grandes, 45 fr. ; petites, 120 fr. les 100 kil.

Ne seront considérées comme petites peaux que celles qui pèsent moins de 1 kil.

Peaux corroyées, entières ou en morceaux, autres que pour les tiges de bottes, 100 fr. les 100 kil. ; vernies, teintes, ou maroquinées, 700 fr. les 100 kil.

Tiges pour bottes (avant-pied, derrières et devants), en peaux corroyées, 200 fr. les 100 kil. ; en peaux vernies, teintes ou maroquinées, 700 fr. les cent kil.

Peaux préparées à l'alun : hongroyées, 40 fr. les 100 kil., mégissées, 50 fr. les cent kil. ; teintes, chamoisées, 250 fr. les 100 kil. ; autres, 700 fr. les 100 kil.

Ne pourront être réunies dans un même colis des peaux taxées à des droits différents.

Ouvrages en peaux ou en cuir, sauf ceux repris sous la dénomination de *mercerie commune ou fine :* Sellerie autre que la sellerie grossière, 2 fr. 50 le kil ; gants de peau, 30 fr. le kil. ; autres, y compris la chaussure, 30 0/0 de la valeur.

Plaques de toute sorte, 9 fr. le kil.

Coutellerie, 35 0/0 de la valeur à convertir en droits spécifiques par le comité consultatif des arts et manufactures.

Ouvrages en métaux autres que ceux nominativement tarifés ou repris sous la dénomination de *mercerie :* en fonte, chaque pièce pesant 25 kilogr. ou moins, 50 fr. les 100 kil. ; de 26 kil. à 100 inclusivement, 40 fr. les 100 kil. ;

de 101 kil. à 500 inclusivement, 30 fr. les 100 kil.; 501 kil. et au-dessus, 20 fr. les 100 kil.

En fer, tôle ou en fer-blanc, chaque pièce pesant 15 kil. ou moins, 100 fr. les 100 kil.; de 16 kil. à 150 inclusivement, 75 fr. les 100 kil.; plus de 150 kil., 50 fr. les 100 kil.

Les ouvrages polis ou émaillés paieront le double des droits ci-dessus, selon l'espèce.

En acier, mêmes droits que les ouvrages en fer, augmentés d'un quart.

En cuivre : pur ou allié de zinc, 100 fr. les 100 kil.; bronzés, argentés, ou dorés, 200 fr. les 100 kil.

En zinc et autres métaux non dénommés, 100 fr. les 100 kil.

En étain ou en plomb, 200 fr. les 100 kil.

Voitures suspendues, garnies, ou peintes, 30 0/0 de la valeur.

Tabletterie : en ivoire, unie, 4 fr. le kil.; sculptée, 16 fr. le kil.

En nacre, gravée, sculptée ou non, 7 fr. le kil.

En écaille, gravée, sculptée ou non : Peignes, 5 fr. le kil,; autres, 19 fr. le kil.

En laque, 3 fr. le kil.

En bois, avec ou sans incrustations, 15 0/0 de la valeur.

En os, corne ou en toute autre matière non dénommée : unie, 1 fr. 50 le kil.; sculptée, 4 fr. 50 le kil.

Nécessaires de toilette ou de voyage: communs, 6 fr. le kil.; fins, 18 fr. le kil.

Dispositions Réglementaires.

Art 2. Le titre VI. de la loi du 28 Avril 1816 et les articles 41, 42, 43, 45, 46, et 47 de la loi du 28 Avril 1818 sont abrogés.

Néanmoins, les marchandises à l'égard desquelles la prohibition est remplacée par des droits, continueront d'être soumises aux autres dispositions relatives au régime du prohibé, et notamment à celles qui sont rappelées à l'art. 3 de la loi du 5 Juillet 1836.

Art. 3. En cas de contestation au sujet de la valeur déclarée des merchandises dont la taxe porte à la fois sur le poids et sur la valeur, il sera statué par les commissaires experts institués par l'art. 19 de la loi du 27 Juillet 1822.

Quant aux marchandises tarifées uniquement à la valeur, l'administration des douanes, en cas de fausse déclaration, fera usage du droit de préemption, tel qu'il est réglé par la loi du 4 floréal an IV.

Ce projet de loi a été délibéré et adopté par le conseil d'Etat dans sa séance du 5 Juin 1856.

Le président du conseil d'Etat,
(Signé) J. Baroche.

RAPPORT A L'EMPEREUR.

SIRE, Paris, le 22 Juillet 1856.

Le projet de loi portant retrait des prohibitions d'entrée inscrites au tarif des douanes n'a pu être décrété dans la session qui vient de finir. La commission du Corps Législatif chargée de l'examiner n'a pas eu le temps de formuler ses conclusions et de présenter son rapport.

Inspiré par une pensée vraiment nationale, celle de mettre le régime douanier de la France en harmonie avec la haute position que son industrie a conquise dans le monde, ce projet de loi a eu la volonté, tout en détruisant d'inutiles prohibitions, de sauvegarder par des droits largement protecteurs, cela a été dit et répété officiellement, les intérêts du travail Français.

Cependant certains représentants des principales industries intéressées dans la réforme proposée ont élevé des réclamations et combattu les appréciations faites, par votre Gouvernement, de l'enquête permanente ouverte et centralisée par l'administration sur toutes ces questions de douanes. Ils ont demandé qu'il fût procédé à une enquête nouvelle et spéciale sur leurs industries et sur le degré de protection dont elles ont besoin pour se défendre contre la concurrence étrangère.

Le laps de temps qui doit s'écouler avant celui de la reprise de ses travaux par le Corps Législatif, permet de recueillir cette information supplémentaire qui, si elle a été jugée n'être pas indispensable dans le principe, n'en est pas moins utile.

Votre Majesté a donc décidé, sur ma proposition, que le vœu exprimé au nom de certaines industries serait accueilli, et m'a chargé de rechercher le mode le meilleur et le plus convenable de procéder à l'enquête demandée.

Sous les anciens gouvernements, le conseil supérieur du commerce a été appelé à porter ses investigations sur les produits suivants :—

En 1828–29, sucres et fer.
En 1832–33, houilles.
En 1834, marchandises prohibées.
En 1837, fils et toiles de lin et de chanvre.
En 1838, fils de laine tordue et grillée.

L'article 3 du décret rendu par Votre Majesté le 2 Février 1853 et qui institue le nouveau conseil supérieur du commerce, de l'agriculture et de l'industrie, donne à ce conseil, entre autres attributions, celle de procéder aux enquêtes. Déjà, en Décembre 1853, le conseil a exercé cette attribution dans la question relative aux cotons filés.

Les précédents et le décret de 1853 désignent donc cette institution comme présentant les plus grandes garanties d'expérience et d'impartialité pour l'accomplissement d'une telle mission.

En conséquence, j'ai l'honneur de vous proposer, Sire, de charger de cette enquête le conseil supérieur du commerce, de l'agriculture et de l'industrie, dans le sein duquel serait immédiatement choisie une commission nommée par arrêté ministériel.

Les documents ainsi recueillis et les appréciations qui en seront faites par le conseil supérieur seront ensuite soumis aux délibérations du Gouvernement de Votre Majesté.

Quelle satisfaction plus complète pourraient réclamer tous les intérêts légitimes? Les esprits les plus enclins à s'alarmer ne doivent-ils pas être pleinement rassurés par ces témoignages de votre haute sollicitude pour la prospérité des industries qui font la gloire et la richesse de l'Empire, comme pour le bien-être des ouvriers qu'elles emploient?

Il est d'ailleurs utile, Sire, de rappeler que, lors de la discussion du projet de loi avec la commission du Corps Législatif, Votre Majesté a décidé que les tarifs destinés à remplacer les prohibitions ne devront pas être appliqués avant le 1er Juillet 1858.

Le conseil supérieur a fait deux pertes bien regrettables par le décès de M. le duc de Mouchy, et par celui de M. Legentil, président de la chambre de commerce de Paris.

J'ai l'honneur de proposer à Votre Majesté de remplir ces deux vacances, et d'appeler au conseil supérieur du commerce M. Germain Thibaut, président de la chambre de commerce de Paris, et M. Clerc, président de la chambre de commerce du Havre.

Si Votre Majesté agrée cette proposition, je la prierai de vouloir bien revêtir de sa signature le décret ci-annexé.

Je suis avec un profond respect,

Sire,
De Votre Majesté,
Le très-humble et très-obéissant serviteur et fidèle sujet,
Le ministre de l'agriculture, du commerce, et des travaux publics,
E. Rouher.

NAPOLEON,

Par la grâce de Dieu et la volonté nationale, Empereur des Français,

A tous présents et à venir, salut :

Vu notre décret du 2 Février 1853, qui a reconstitué le conseil supérieur du commerce, de l'agriculture, et de l'industrie ;

Vu le décès de M. le duc de Mouchy, sénateur, et de M. Legentil, président de la chambre de commerce de Paris ;

Sur le rapport de notre ministre secrétaire d'Etat au département de l'agriculture, du commerce, et des trauvaux publics,

Avons décrété et décrétons ce qui suit :

Art. 1er. MM. Germain Thibaut, président de la chambre de commerce de Paris,

Et Clerc, président de la chambre de commerce du Havre,

Sont nommés membres du conseil supérieur du commerce, de l'agriculture, et de l'industrie.

Art. 2. Notre ministre de l'agriculture, du commerce, et des travaux publics est chargé de l'exécution du présent décret.

Fait à Plombières, le 24 Juillet 1856.

NAPOLEON.

Par l'Empereur :
Le ministre secrétaire d'Etat au département de l'agriculture, du commerce, et des travaux publics,
E. Rouher.

Le ministre de l'agriculture, du commerce, et des travaux publics,

Vu le décret du 2 Février 1853, qui a reconstitué le conseil supérieur du commerce, de l'agriculture, et de l'industrie, avec faculté de procéder à des enquêtes lorsqu'il y est autorisé par le Gouvernement ;

Vu le rapport adressé par nous le 22 de ce mois à S. M. l'Empereur ;

Vu le décret du 24 de ce mois, qui nomme membres du dit conseil supérieur MM. Germain Thibaut et Clerc ;

Arrête :

Art. 1er. Une commission choisie parmi les membres du conseil supérieur du commerce, de l'agriculture et de l'industrie, est instituée pour procéder aux enquêtes qui seront jugées nécessaires pour l'examen des tarifs inscrits dans le projet de loi portant retrait des prohibitions du 9 Juin 1856.

Art. 2. Sont nommés membres de cette commission :

MM. Baroche, président du conseil d'Etat, président ;
Reveil, vice-président du Corps Législatif ;
Gréterin, conseiller d'Etat, directeur général des douanes et des contributions indirectes ;
Germain Thibaut, président de la chambre de commerce de Paris ;
Clerc, président de la chambre de commerce du Havre ;
Fleury, chef de la division du commerce extérieur ;
Ozenne, chef du bureau de la législation des douanes de France, secrétaire.

Art. 3. M. His de Butenval, conseiller d'Etat, commissaire du Gouvernement et rapporteur du projet de loi portant retrait des prohibitions, est nommé membre de ladite commission.

Art. 4. Sont nommés adjoints à la commission :

MM. de Forcade la Roquette ;
Ernest Baroche, maître des requêtes au conseil d'Etat.

E. Rouher.

Fait à Paris, le 27 Juillet 1856.

Extract from the "Moniteur, *Paris, le 16 Octobre.*"

A la suite de l'Exposition universelle de 1855, les progrès de notre industrie avaient été si bien constatés que le moment avait paru opportun pour remplacer par des droits protecteurs les prohibitions inscrites dans nos lois de douanes. C'était un grand pas vers le but auquel doivent tendre tous les peuples. En effet, le développement de l'activité commerciale et des relations internationales prépare les progrès de la civilisation.

Profondément convaincu de cette vérité, le Gouvernement avait présenté au Corps Législatif un projet de loi levant toutes les prohibitions. Cette loi n'a pu être votée dans la dernière session, et le Gouvernement, voulant s'entourer de toutes les lumières, avait décidé qu'une enquête serait ouverte sur ces questions.

Dans ces circonstances, des alarmes exagérées ont cependant été répandues dans le pays et exploitées par les partis. Sa Majesté a voulu que les réclamations qui lui étaient parvenues fussent étudiées avec le plus grand soin, et a donné l'ordre au ministère de l'agriculture, du commerce et des travaux publics d'en faire l'examen.

Eclairé par le rapport du ministre sur la véritable situation de notre industrie, l'Empereur a décidé que le projet de loi soumis au Corps Législatif serait modifié en ce sens, que la levée des prohibitions n'aurait lieu qu'à partir du 1er Juillet 1861. Un projet de loi conforme a été immédiatement envoyé au conseil d'Etat.

L'industrie Française, prévenue des intentions bien arrêtées du Gouvernement, aura tout le temps nécessaire pour se préparer à un nouveau régime commercial.

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